The FOUNDRY

Volume 48. No. 13
Whole No. 350

Published
Semimonthly

CLEVELAND, OHIO, JULY 1, 1920

Adapt Ingot Foundry To Castings

Old Plant Acquired By a New Company is Remodeled—Reverberatory Furnace Has Been Transformed Into a Core Oven—Indirect-Arc Rocking Electric Melting Furnace Is Being Used

BY H. E. DILLER

IF THE average foundry manager or superintendent were to design a foundry for a large tonnage of castings, he would enlist the aid of a staff of specialists to assist him. An architect familiar with foundry design would be essential to plan a building for the conveying machinery and cranes; mechanical engineers would be consulted to secure the most efficient arrangement inside the building, and electrical engineers would be called on to design the power layout. Other experts and specialists would be needed to insure that no mistakes were made which might in the end result in heavy financial loss. Obviously, such a staff of consultants could be hired only when the problem was of sufficient importance to warrant a large outlay. A more common procedure, particularly when the foundry is of moderate size, entails the application of all the combined experience of those actively in charge of the old plant. The executives take counsel with the superintendent, and draw upon the fund of knowledge which all concerned have accumulated through their own experience or through the medium of technical literature. This knowledge when used with a liberal admixture of common sense, and an appreciation of the shop's peculiar problems, often results in an unusually efficient plant.

The problem of design is comparatively easy when a new structure is to be erected and every point can be considered in its proper relative importance. However, when the building already is erected, and it is necessary to fit the foundry to what already exists, some interesting problems are encountered. Whoever places the equipment should be familiar with the plant's needs and also with all the various apparatus on the market to meet the requirements for otherwise, unsuitable and inefficient equipment may be installed. The Hills - McCanna Co., Chicago, was confronted with the problem of adapting an old

FIG. 1—A BATTERY OF FIVE CRUCIBLE FURNACES IS USED TO MELT METAL FOR CASTINGS—COAL HAS PROVED A GOOD FUEL

building to meet its needs when, toward the end of last year, the foundry building in which the company was operating was found to be too small. An opportunity offered to purchase the foundry of the Denny-Rine Co. on Elston avenue, Chicago. In taking this step, the judgment of three men in the company was relied upon. These men, it might be thought that the cores nearest to the fire would be burned, but by keeping a full bed of coals and an exceedingly slow draft the whole oven is held at a comparatively uniform temperature. The majority of cores are small and may easily be handled on trays by hand.

One of the greatest problems concure the entire layout at once, but at first installed overhead tracks from the furnaces to the pouring floor. Ultimately a system as detailed in Fig. 2 will completed.

At present the two lines at the top of the illustration which converge and pass in front of the electric furnace and over the crucible furnaces are the

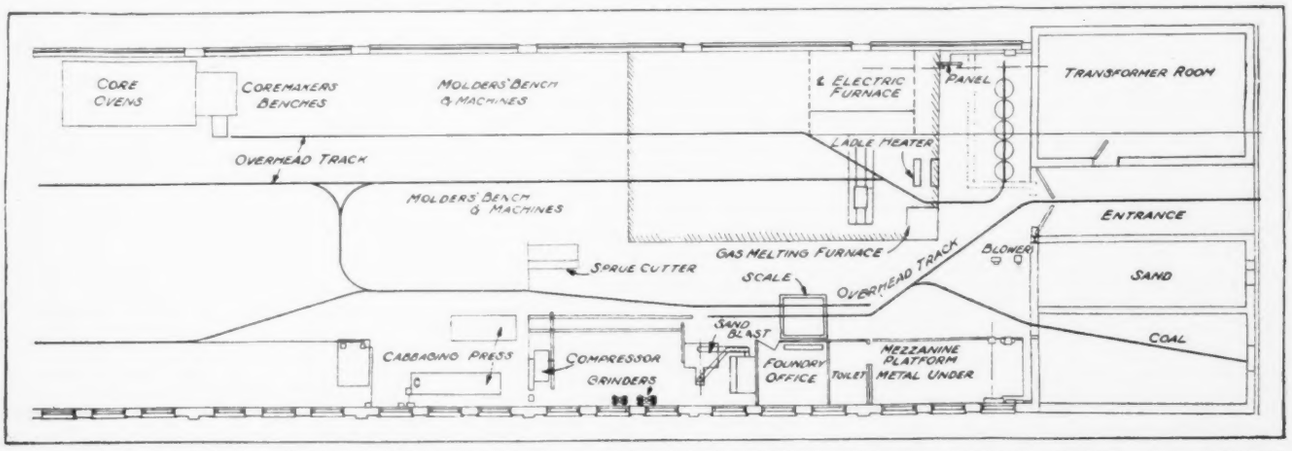


FIG. 2—ONE LINE OF THE CONVEYING SYSTEM EXTENDS OVER THE CRUCIBLE FURNACES, PAST THE ELECTRIC FURNACE, AND BRANCHES INTO TWO LINES ACROSS THE MOLDING DEPARTMENT—THESE ARE CONNECTED WITH ANOTHER BRANCH ON WHICH CASTINGS ARE CARRIED TO THE CLEANING DEPARTMENT

executives of the company, are A. H. Noyes, president; A. H. Smith, secretary and treasurer, and J. W. Dyer, superintendent.

The Denny-Rine plant had been used for making nonferrous ingots and was not equipped with a conveying system or other facilities for making castings. However, it did possess an electric melting furnace and a cabbaging machine, both of which were retained in their original position by the Hills-McCanna Co.

There also was a reverberatory furnace which had been in service at one end of the shop. This was retained, but was converted into a core oven in an interesting manner. The bottom which sloped to the tap hole at the end opposite to the firing chamber, and which was built to disa in from the sides to the center, was leveled to a point slightly below the tap hole. The first intention was to make the bottom of the improvised core oven at the floor level; but when it was found that the foundation under the bottom lining was solid concrete, the level of the floor of the new core oven was not carried any lower. In addition to leveling and slightly lowering the bottom, the bridge wall was lowered and after racks were placed inside the oven, the reverberatory furnace was completely transformed into a serviceable core oven. The fire box was not changed. Anthracite coal is used for fuel, the location of the firing door being evident from Fig. 8. The racks shown through the open door are quite near the fire and fronting the new company was the establishment of a transfer system for conveying the metal to the molds and for carrying the castings to the cleaning department and out to the shipping room. It was decided to install overhead trolleys and the system only ones in service. Material has been ordered for the tracks shown at the bottom of the illustration. Connection will be made with the present system through the switches as shown, so that castings may be loaded on carriers, two of which have been

OPERATION OF
DETROIT ROCKING ELECTRIC BRASS FURNACE

FURNACE No._____ DATE_____

	HEAT NO. 13	HEAT NO. 14	HEAT NO. 15	HEAT NO. 16	HEAT NO. 17	HEAT NO. 18	HEAT NO. 19	HEAT NO. 20
CHARGE	230 Bush 270 Cu Apr 27	230 270 Apr 28	230 270	230 270	230 270	233 276	230 270	
TIME ARC ON	2.30	7.25	9.20	11.00	12.53	2.15	3.27	
METER READING ARC ON								
TIME START ROCK								
METER READING START ROCK								
TIME ARC OFF	3.25	9.00	10.30	12.02	1.50	3.07	4.20	
METER READING ARC OFF								
Kilowatts Used	65	100	95	80	70	63	65	
REMARKS								

FIG. 3—THE DAILY HEAT RECORD GIVES A DETAILED HISTORY OF THE ELECTRIC FURNACE OPERATIONS—NOTE THE POWER CONSUMPTION DROPS FROM 100 KILOWATTS FOR THE FIRST HEAT OF THE DAY TO 63 KILOWATTS FOR A LATER HEAT

manufactured by the Louden Machine Co., Fairfield, Iowa, was chosen. The features of this system which appealed to the company were the prompt delivery on materials required and simplicity which made it possible to erect the units with the company's own workmen. The company did not seordered, and carried to the sprue cutter and cleaning section. Castings are cleaned in a small sandblast barrel supplied by the American Foundry Equipment Co., New York. When castings are taken from the sandblast barrel they are sorted and placed in tote boxes set upon a push truck by

which they are carried to the shipping room. The tote boxes used are the nesting type, manufactured by the New Britain Machine Co., New Britain, Conn. Lugs of pressed steel are formed on the ends of each box, as illustrated at *A-A*, Fig. 10. These lugs rest upon the ends of the box beneath when they are stacked and so allow a nest to be formed, as may be seen on the truck in Fig. 10. The cleaning section also is equipped with a magnetic separator built by the Dings Magnetic Separator Co., Milwaukee.

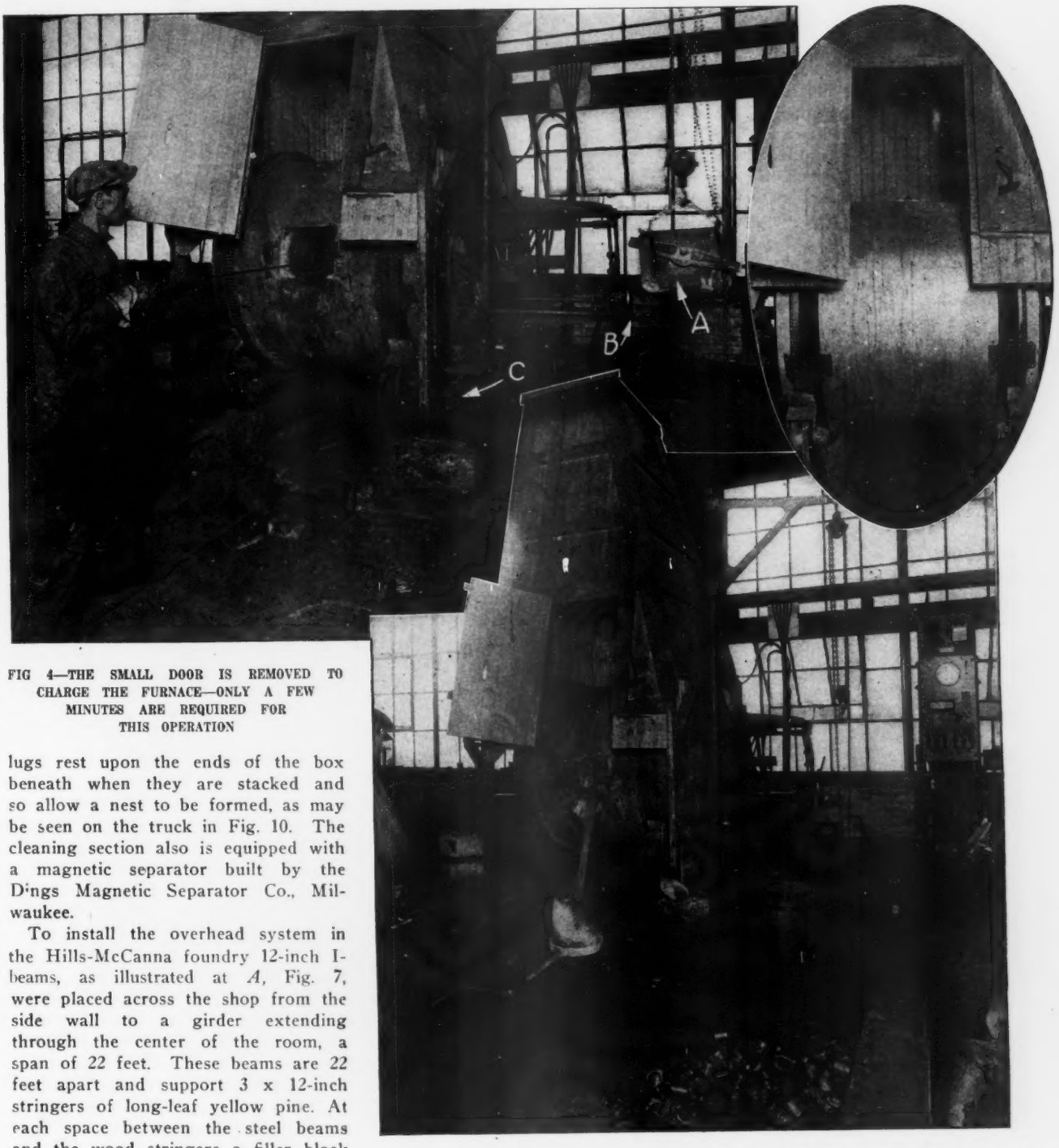


FIG 4—THE SMALL DOOR IS REMOVED TO CHARGE THE FURNACE—ONLY A FEW MINUTES ARE REQUIRED FOR THIS OPERATION

To install the overhead system in the Hills-McCanna foundry 12-inch I-beams, as illustrated at *A*, Fig. 7, were placed across the shop from the side wall to a girder extending through the center of the room, a span of 22 feet. These beams are 22 feet apart and support 3 x 12-inch stringers of long-leaf yellow pine. At each space between the steel beams and the wood stringers a filler block 48 inches long with a cross section 3 x 10 inches is set. The two stringers which end at the point directly under the I-beam are held to the beam by strapbolts which pass over the beam and down each side, through the filler block and one end of each of the two stringers, being fastened to the stringers with nuts and washers. Near each end of the filler block a bolt supplements the strap bolt in attaching the stringer to the block. Hangers which carry the steel rail are affixed to the stringer at intervals of 18 inches. This installation will carry loads up to 1000 pounds. The rail, hangers and trolleys were supplied ready for installation.

Chain blocks are attached to trolleys for carrying the molten metal to the molds. A row of molds can be arranged along each side of both overhead lines, and by piling one mold on another a large number of molds may be placed on the floor at one time. Fig. 7 shows a row of molds being poured. Another row sometimes is set back of the workman who is pouring, and these may be reached by the ladle when the latter is swung around. One of two gyratory riddles made by the Great Western Mfg. Co., Leavenworth, Kans., may be seen hanging on the conveyor at the right in Fig. 7.

FIG. 5—A BUGGY HOLDING THE CONTAINER IS PUSHED TOWARD THE FURNACE AS THE DRUM IS REVOLVED TO POUR THE METAL FIG. 6—THE FURNACE IS REVOLVED SO THAT THE TAP HOLE IS ROTATED THROUGH AN ARC OF MORE THAN 200 DEGREES

At present, most of the molds are made at 10 benches arranged on both sides of the molding floor. Two molding machines of the jolt-squeezer type, manufactured by the U. S. Molding Machine Co., Cleveland, have been installed. These machines are proving valuable for the class of work made by the Hills-McCanna company, and more will be ordered to care for some of the work now being made at tubs.

As has been said, the company became owner of a small electric furnace when control of the foundry was acquired. This furnace, shown in Figs. 4, 5 and 6, is the indirect-arc type, manufactured by the Detroit Electric Furnace Co., Detroit under license from the United States bureau of mines. Its capacity is 500 pounds. At first this furnace was used primarily for ingot metal, which afterward was remelted for the company's own use in castings, or was sold under specifications which were rigidly observed, covering the alloy content. Through experimentation, the company found that it is possible to pour castings directly from the furnace and at present follows this practice in producing red brass and bronze castings. Excellent results are being obtained on worm gear castings made from government bronze melted in the furnace and poured direct by hand ladles.

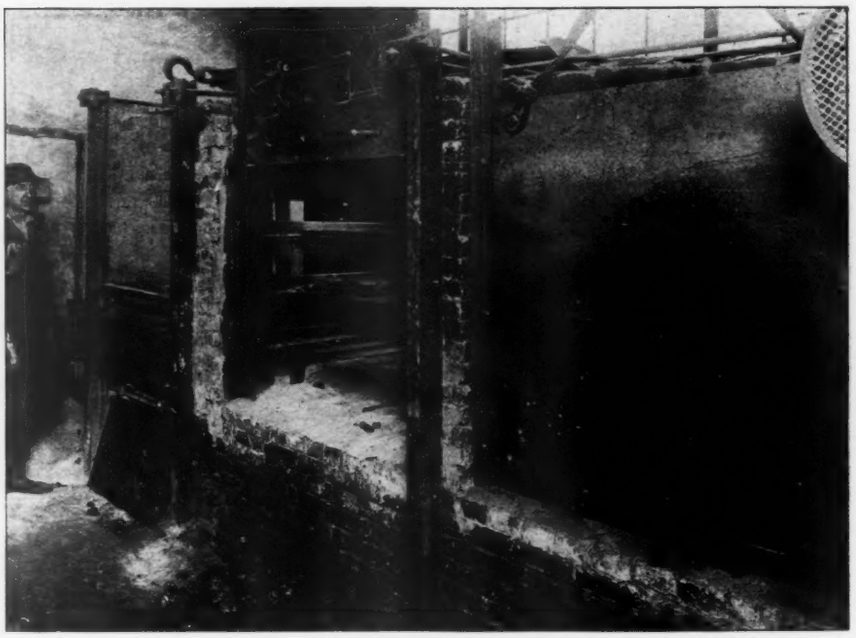


FIG. 8—A REVERBERATORY FURNACE HAS BEEN TRANSFORMED INTO A CORE OVEN BY LEVELING THE BOTTOM AND LOWERING THE BRIDGE WALL

FIG. 7—WOOD STRINGERS HUNG ON I-BEAMS CARRY THE RAIL FOR THE OVERHEAD CONVEYING SYSTEM—NOTE THE RIDDLE ATTACHED TO THE ONE TROLLEY WHILE ANOTHER TROLLEY CARRIES THE METAL FOR POURING

The company specializes in the manufacture of high class bronzes. The castings made for its own use must stand a water pressure test, and the castings made for outside firms must meet rigid specifications. One of the guarantees which the company gives to its customers is that the castings will be within certain limits for composition and will stand prescribed physical tests. In case of failure the company allows credit for the cost of the casting as well as any machine expense which has been put on the defective casting. This naturally makes for conservatism in trying new methods. When work was started in this foundry in Dec., 1919, only 1000 pounds of castings a day were made. This output has been increased until by the first of May production had reached an average of 2700 pounds of cleaned castings a day. This amount is constantly being increased and the company expects soon to have requirements enough to utilize the entire output of electric furnace metal.

The furnace charge is made up of scrap copper wire, bushings or other scrap with any new metal necessary to give the resulting metal the required composition. The wire formerly was compressed into rectangular bales in the cabbaging machine shown in Fig. 9. This machine was built by the Logeman Bros. Co., Milwaukee. About 25 or 30 tightly compressed bundles could be made on it, in an hour. The weight of these compressed

FIG. 9—COPPER WIRE FORMERLY WAS COMPRESSED INTO BALES FOR THE FURNACE—THE AIR COMPRESSOR MAY BE SEEN AT THE LEFT

masses varied somewhat according to the sizes of wire used, but the average bundle weighed about 70 pounds.

The company recently has decided to abandon the use of the cabbaging machine. The space at present occupied by this equipment is badly needed for other purposes. Further, the premium offered by smelters for scrap material for refining makes uneconomical the reclamation in shops where specification limits are rigidly observed.

Charging the Furnace

To charge the furnace, the door above the tapping spout is unclamped and lifted off by a chain block hung on a swinging standard. The door may be seen at *A*, Fig. 4, which shows the beginning of a charge. One block of copper wire is being pushed into the furnace and the others for the charge are on the ground in front of the furnace. After all the copper wire has been placed in the furnace a portion of the smaller scrap is shoveled in and the furnace is rocked slightly to settle the scrap. Then a path is cleared for pushing in one of the electrodes, both of which had been withdrawn before charging was started. Three-inch graphite electrodes are used. The furnace again is rocked and an additional amount of the charge is put in. The second electrode then is pushed into the furnace close enough to the other electrode so that an arc will be made when current is turned on. The remainder of the charge is added, and after the door is closed the furnace is ready to be started.

During the heat, one electrode is held stationary and the length of the arc is controlled by moving the other. This is effected by a screw operated through the wheel *B*, Fig. 4. It is necessary for the melter to be at this wheel constantly during the heat as the electrode needs frequent regulation. The switchboard which carries a wattmeter and a voltmeter may be seen plainly to the right in Fig. 5.

The furnace is held stationary until the charge is almost entirely melted, after which it is rocked. It can not be rocked before this time on account of danger from heavy pieces of metal striking the electrodes and breaking them. The rocking period lasts about 20 to 30 minutes. At first the furnace is rocked through only a small angle, but this gradually is increased until towards the end of the heat the furnace is turned as far as possible without pouring metal from the spout on either side. The furnace is carried on four idler wheels and is rocked by a motor acting through a pinion on the two gears shown in the illustrations around each end of the cylindrical barrel of the furnace. The angle of rocking is regulated by changing a pin in a controller box shown at *C*, Fig. 4.

The furnace is shown tilted back while rocking in Fig. 6. The light spot shown in the hood is caused by the light from the electrodes coming through a small opening at the pouring spout. During the heat the hole at the pouring spout is partly closed with a brick but it is necessary to allow a small opening for the escape of fumes which would exert considerable pressure in the furnace if not allowed to escape. Such fumes are carried away through the hood which has been built close to the furnace to secure a strong draft.

Tapping the Furnace

When the metal is hot enough to pour, the brick is taken from in front of the tap hole and a ladle or crucible is placed on the car which travels on a track to the front of the furnace as shown in Fig. 5. As the furnace tilts it is necessary to bring the container closer to it. This is accomplished by pushing the car with a bar. As soon as the container is full it is taken to a row of metal pig molds and poured into ingots.

FIG. 10—CASTINGS ARE SORTED INTO TOTE BOXES WHEN THEY ARE TAKEN FROM THE SAND-BLAST BARREL—THEY ARE CARRIED TO THE SHIPPING DEPARTMENT ON A PUSH TRUCK

A characteristic day's log of the furnace is shown in Fig. 3. The charge in each case consisted of 230 pounds of scrap bushing and 270 pounds of copper wire. The first heat recorded on this chart was cast April 27. The next heat was the first taken off April 28. It was started at 7:25 a. m. and pouring was begun at 9:00 a. m., which showed 1 hour and 35 minutes for the heat. The total power required was 100 kilowatt hours. Contrasting this with the last two heats of the day which were melted in 52 minutes respectively, and required 63 and 65 kilowatt hours each, the effect of a cool furnace is noted.

Intermittent Operation

After the last heat, the furnace is charged and closed ready to start in the morning, but considerable heat is lost in standing the intervening 15 hours. Were the furnace operated on a 24-hour schedule the average power consumption could probably be kept below 65 kilowatts for the 500 pound charge, and certainly below 70 kilowatt hours. At the latter figure the power consumption per ton of metal charged would be 280 kilowatt hours.

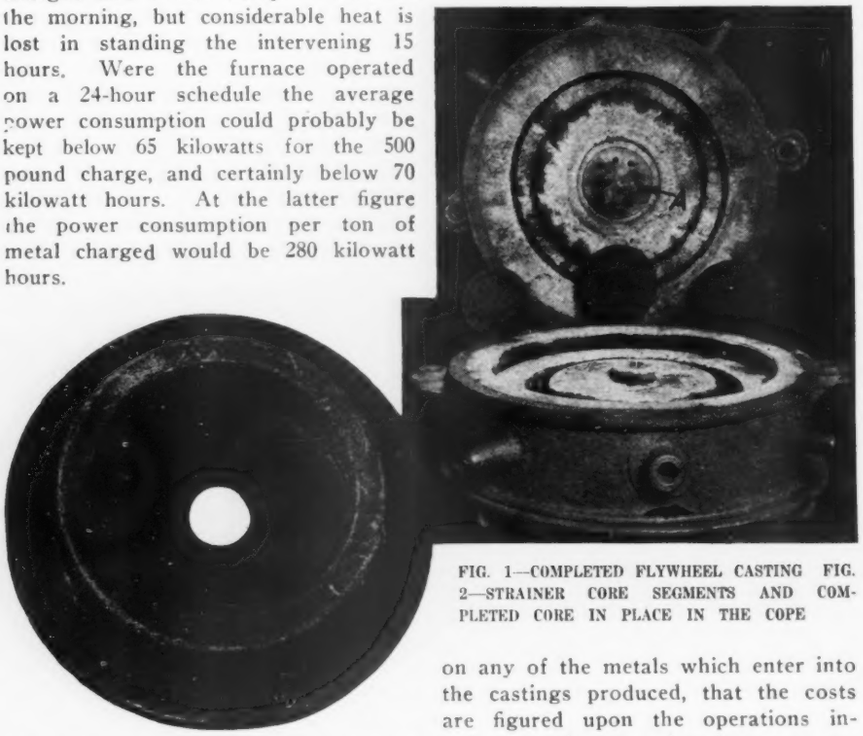


FIG. 1—COMPLETED FLYWHEEL CASTING FIG. 2—STRAINER CORE SEGMENTS AND COMPLETED CORE IN PLACE IN THE COPE

The chart shows that six heats were taken off from 7:25 o'clock in the morning until 4:20 in the afternoon. However, a considerable loss of time is shown between each two successive heats. Twenty minutes elapsed between pouring the first heat and starting the arc on the second heat. Similarly 30, 51, 25 and 20 minutes respectively elapsed between the succeeding heats. The loss of time partly was due to the fact that the metal was poured into a crucible. This necessitated waiting to charge the furnace until the metal from the crucible was poured into ingots and a second tap was made. The furnaceman also helped to pour the metal into ingots, which delayed recharging. If the furnace man is not required to pour the metal he may begin charging as soon as the metal is poured. In this way less than 10 minutes will be consumed from the time of tapping until the arc again is melting another charge, and seven heats can be taken in a day.

Frequent analyses, to check the work of the melter, are made in the laboratory which the company has established. With this information accurate mixtures can be made for melting in crucibles when casting in which scrap metal is permitted to be poured. However, on most of the castings only virgin metal enters into the mixture. The company rigidly adheres to the principle of absolute honesty in all of its products. The chemical composition is guaranteed to the customer, and no substitution, nor cheapening is permitted in any of its metals. The statement is made that no profit is figured on any of the metals which enter into the castings produced, that the costs are figured upon the operations involved, and that, therefore, no excuse exists for substituting metals.

Five crucible pits are used for melting metal for castings. In addition to these, a gas crucible furnace has been added to the melting equipment. No. 100 crucibles are used in four pits and the fifth pit carries a No. 60 crucible. Coal is used as a fuel and it is thought to be preferable to coke. One advantage it has is that enough coal can be placed in the pit when the crucible is charged to last through the heat, whereas an addition must be made during the middle of the heat when coke is employed. About 0.55 pound of coal is required to a pound of alloy.

John J. Murray has been appointed eastern sales representative for the Canton Steel Foundry Co., Canton, O. with offices at 120 Broadway, New York.

Uses Special Strainer On Flywheels

The Nash Motor Co., Kenosha, Wis., employs an efficient method for producing flywheel castings for its 6-cylinder passenger automobile. One of those castings is shown in Fig. 1. The main consideration in a casting of this nature is clean metal. To secure this the special skim gate, *A*, shown in place in the cope in Fig. 2 is employed. This gate is formed of three separate cores, which are shown leaning against the cope. The core to the right forms the top, while the plain ring core is the center and the one to the left is at the bottom and opens into the mold. The three cores are pasted together and baked. The strainer thus formed is set and rammed in place with the cope forming the bottom of a box cut into the top of the cope.

The coreboxes used in forming the perforations in the top and bottom disks have pins which cut the small holes in the upper and lower sections, almost entirely through the core. After the sections are baked, they are sent to a small bench drill, which is used to cut the holes entirely through the core. The boss shown at the center in the drag comes in contact with the center of the skim gate core and forms the opening shown in the flywheel casting.

At the Nash plant four men and a separate pouring gang during last winter produced 180 flywheels per day using two molding machines, one for the cope and the other for the drag. As the operation is practically continuous, the problem of floor space, to keep the work as close to the machine as possible, is important. Conservation is accomplished by pouring a floor of molds as soon as it is ready, and then placing additional molds upon the tops of those already poured. A night gang shakes out the castings and prepares for the following day's production.

A Correction

In the description of the Long & Allstatter Co. foundry, Hamilton, O., which appeared in the June 15 issue, the name of the maker of the heating equipment was erroneously stated. This equipment which comprises three large air heaters was manufactured by Skinner Bros. Mfg. Co., Inc., 1022 Tyler street, St. Louis.

The National Engineering Co., Chicago, manufacturer of the Simpson foundry mixer, has changed its eastern office to 1760 Woolworth building, where S. H. Cleland will have charge as eastern sales manager.

Making Foundry By-Product Coke

Proper Blending of Coals and a Knowledge of the Ratio of Heat Applied to the Oven Area Is Essential—Some Common Points to Observe in Judging Coke Are Noted

BY EDWARD H. BAUER

WHEN coal is pulverized, mixed with air and ignited, it can be made to explode. This is due to minute particles of coal being surrounded by an atmosphere of oxygen in sufficient quantities to support complete combustion in a short space of time. A 1-inch cube of coal will have 6 square inches of surface exposed to the air or oxygen, but if this same 1-inch cube is pulverized, the area exposed to the oxygen will be thousands of times greater and, consequently, if coal is ignited in this state, the burning will be so rapid it may be called an explosion. Coke under the same conditions will act in a similar manner.

From this, it is seen that coke which exposes a large surface to the blast will burn more readily than one which is dense and compares with a hard coal such as anthracite. Hence, a foundry coke must have an open cell structure in order to expose a large area of it to the blast. Further, the coke in the bottom of the cupola must carry the weight of all the burden above it and, therefore, must have sufficiently strong cell walls.

The cell structure in the coke may vary from what is termed *sponge* to a degree so hard as to almost compare with anthracite. Naturally the dense coke will carry more burden than sponge and the sponge will burn faster than the dense coke. Therefore, a good foundry coke should have both characteristics. The cell structure should consist of hard, thin walls, but the walls at the same time, should be strong. As John Fulton, the pioneer investigator of coke, expressed it, "Furnace gases cannot operate on cell space; they can only act on the exposed surfaces." Therefore, the space is nothing and cannot be used, but the cell wall and the surfaces which are exposed are the important factors.

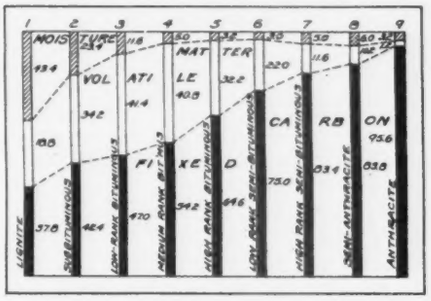


FIG. 1—GRAPHIC REPRESENTATION OF THE CHEMICAL COMPOSITION FOUND IN VARIOUS RANKS OF COAL

The structure of the cell wall varies with different conditions under which the coal is coked, such as heats and length of coking time, and also varies with the characteristics of the original coal. Ash content of the coal will tend to strengthen the cell walls, but this ash must be in the correct form. Large particles of ash or inorganic matter will decrease the strength of the coke, as explained later, but finely divided inorganic material will actually strengthen the walls.

If the coke is undercoked, the cell walls will be soft and, consequently, if the volatile matter in the coke is too high, we can safely state that the coke is soft and will not carry the burden but will *mush* down in the cupola. Overcoking will tend to break into smaller pieces, with a better cell wall, but will have a tendency to produce a fingery structure. If the ash is too high, much inert material will be needlessly heated to the fusing point and the efficiency of the cupola lowered. Sulphur in coke mixes with the molten iron in the cupola and produces hard castings. Moisture plays an important part in coke quality, but is overlooked by many. If coke is quenched properly, the moisture will remain low, although the coke is rained on in transit.

The analysis of an ideal foundry coke should be within the following limits:

	Per cent
Volatile Matter	2 or less
Fixed carbon	86 or more
Ash	12 or less
Moisture	2 or less
Sulphur	Less than 1

Some operators seek coke containing moisture plus volatile matter in quantities less than 2 per cent. In order to

Abstracted from a paper presented at a recent meeting of the New England Foundrymen's association. The author, Edward H. Bauer, is engineer of manufacture for the Providence Gas Co., Providence, R. I.

FIG. 2—FINELY PULVERIZED COAL IS FED INTO THE COKING OVENS FROM FOUR HOPPERS

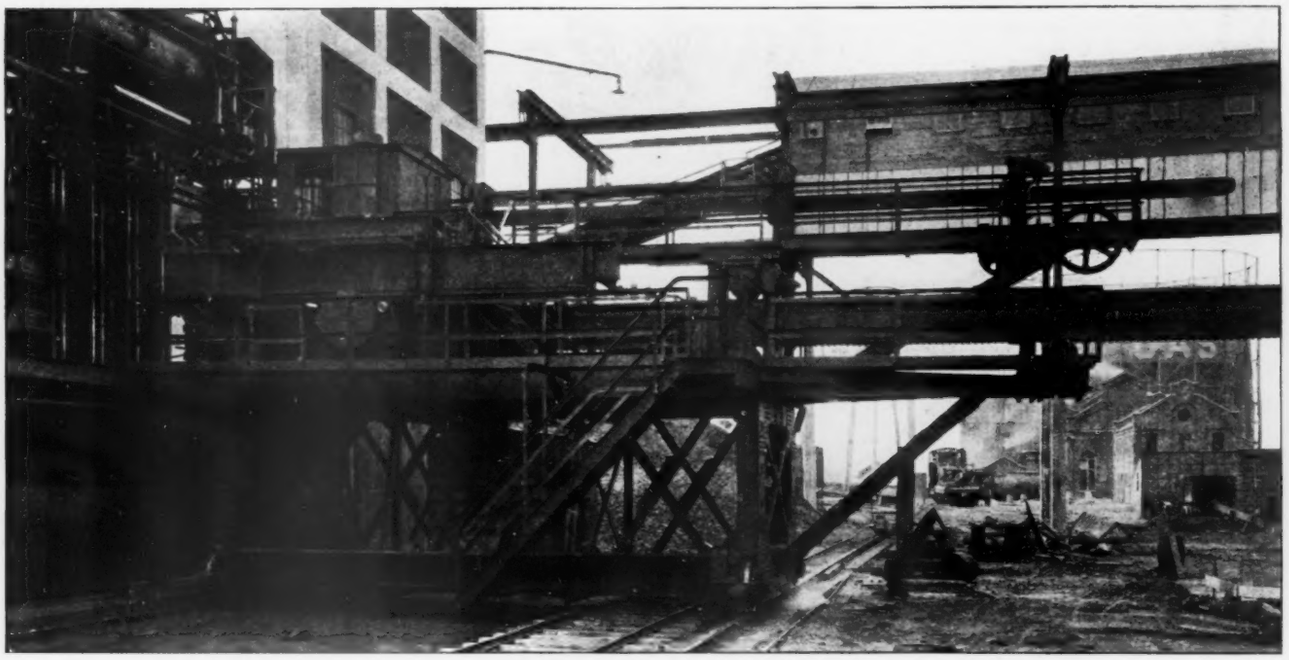


FIG. 3—THE MECHANICAL EQUIPMENT FOR OPENING OVEN DOORS, LEVELING THE CHARGE, AND PUSHING THE COMPLETED COKE INTO CARS IS CARRIED ON ONE TRAVELING FRAMEWORK

drive off the last traces of volatile matter and bring the moisture plus the volatile matter down to such a low percentage, it will be necessary to over-coke part of this coke and thus decrease the size of the lumps.

Coal is of vegetable origin. Through the ages this original vegetation, pressed between heavy layers of rock and subjected to heat, has been converted into what is now termed coal. However, all of this vegetation has not been subjected to the same treatment and probably some of it, while under the same heat and pressure conditions, has not been exposed to the treatment so long and, consequently, the coals of today vary in physical and chemical characteristics.

FIG. 4—THE MACHINE SHOWN IN FIG. 3 REMOVES THE DOORS WHEN COKE APPEARS AS SHOWN IN THE CENTER OVEN, READY TO PUSH

Elements are Similar

Analyses show that the original matter from which coal was formed and the coals of today contain the same elements, namely: carbon, hydrogen, oxygen, nitrogen, sulphur and ash combined in widely different proportions. Analyses also show that changing this vegetation from the decayed mass into coal, through the agencies of pressure, heat and time, consists of the elimination of carbon, hydrogen and oxygen in the forms of carbon dioxide and methane. In other words, the analyses of various coals, from lignite up to anthracite or even graphite, show that the volatile matter and moisture have been gradually driven off and the fixed carbon left behind. Fig. 1 shows this clearly.

There is still another constituent of coal to be considered, and that is resinous matter by virtue of which coal cokes. Coal is an agglomerate of carbon residuum, humus bodies, resinous bodies and hydro-carbons in various proportions. Certain combinations of these bodies give the coal its classification, and in order to have a coking coal, the above bodies must be in correct proportion. If they are not, no coke results.

The high volatile coal—commonly known

FIG. 5—THE HOT COKE IS PUSHED OUT BETWEEN THE GUIDES AND INTO THE QUENCHING CAR FOR REMOVAL TO THE QUENCHING TOWER—THE DELIVERY WHARF IS VISIBLE BELOW THE ELECTRIC LOCOMOTIVE

as *gas coal*—contains from 30 to 40 per cent of volatile matter. It cokes to a certain extent but the coke is friable, has thin, soft walls and is porous. This coal is used in gas works where metallurgical coke is not made. The resulting coke from this coal usually is termed *gas house* coke.

Coking coals have slightly less volatile matter but give a better coke than that made from gas coal but the product will not carry a heavy burden.

Mixing for Quality

Low volatile coal is sometimes called *steam coal.* This is the New River or Pocahontas quality. It contains from 17 to 22 per cent volatile matter, expands on coking, gives a dense coke and is used by mixing a certain portion with the higher volatile coals, to give the resulting coke the proper qualities. All low volatile steam coals cannot be used in the manufacture of coke, but all low volatile coking coals can be used for steaming purposes. Unless these coals contain the proper proportions of humus and resinous bodies, the resulting coke cannot be used for metallurgical purposes.

It is obvious that coke made from either of the three mentioned coals will not give a coke that is suitable for foundry practice, but it has been found that a mixture of these will give an excellent coke, provided the mixture is in correct proportion to suit the conditions of the heat to which it is subjected and the type of oven in which it is coked. A mixture of coals which in one oven with certain heats would give an excellent coke could not be used in an oven of a different type which gives a different heat treatment. For instance, if a certain mixture of high and low volatile coals is handled in two ovens, one 24 inches and the other 17 inches wide, the coking time necessarily will be different with a consequent different heat treatment in the two ovens. This difference in coking time will re-

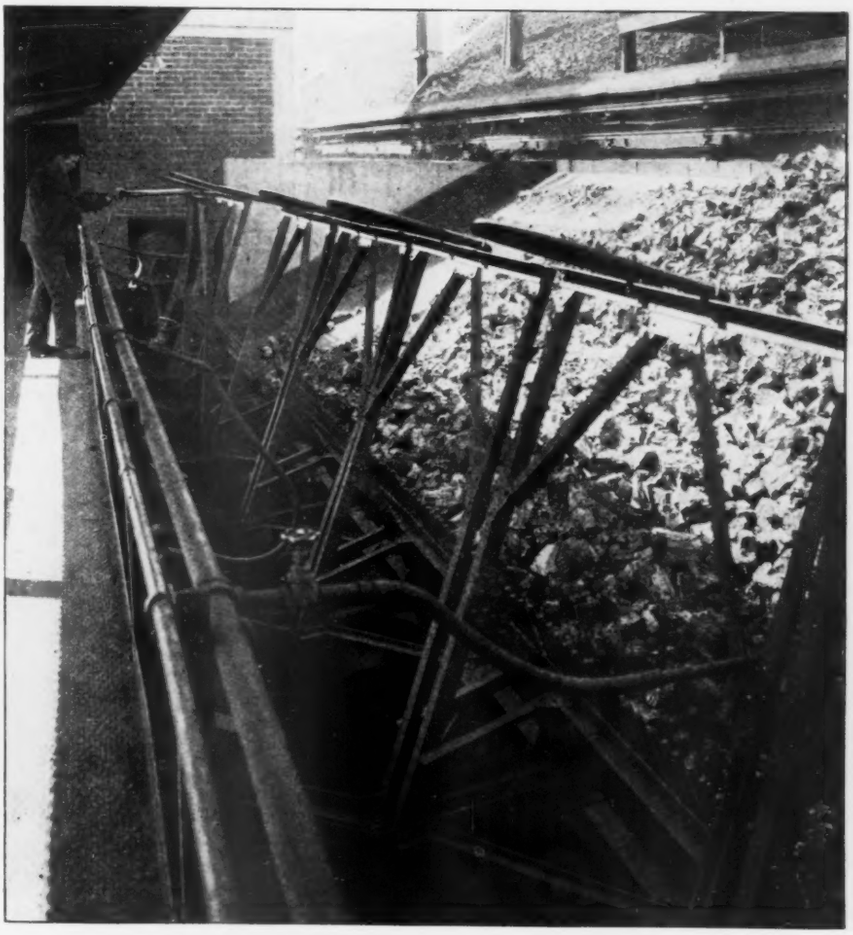


FIG. 6—THE RECEIVING WHARF HOLDS THE COKE AND PERMITS IT TO BE FED REGULARLY UPON DELIVERY BELTS THAT RUN BELOW

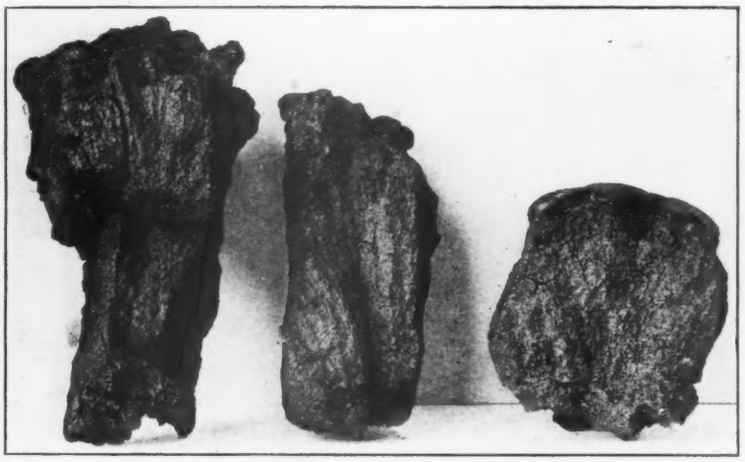


Fig. 7—Coke made of 100 per cent high volatile coal having approximately 28 per cent volatile matter. The two pieces on the left show coal coked in 15 hours, while the piece to the right shows the same coal coked in 30 hours. The short coking time shows the effects of high heats in giving a fingery coke, open cell structure and much cross fracture. The coke made with longer coking time shows a better cell structure, less cross fracture and a more blocky coke.

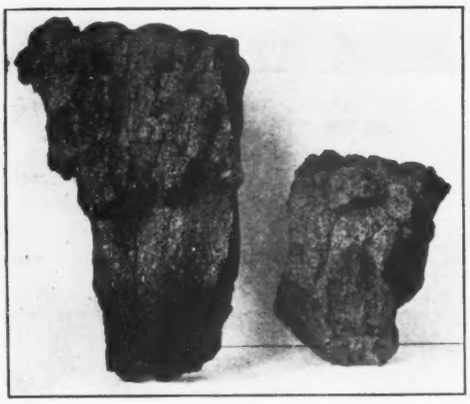


Fig. 8—Left—Coke made of a mixture of 89 per cent high volatile and 11 per cent low volatile coal on 24-hour coking time. This high volatile contains approximately 31 per cent volatile matter. The low volatile contains about 18 per cent. Note the large cell structure, the longitudinal fracture and the irregular cross fracture which is shown by the piece on the left. The piece to the right shows an end view of the cross fracture. Note the fingery structure of this coke. Coke of this type dropped 6 to 8 feet will break into small pieces.

Fig. 9—Right, above—Coke from a mixture of 70 per cent high volatile and 30 per cent low volatile of the same coal. The addition of the 19 per cent low volatile did not help the cell structure to any marked extent but decreased the longitudinal fracture. This did not prove to be a good metallurgical coke, the cell walls being too soft.

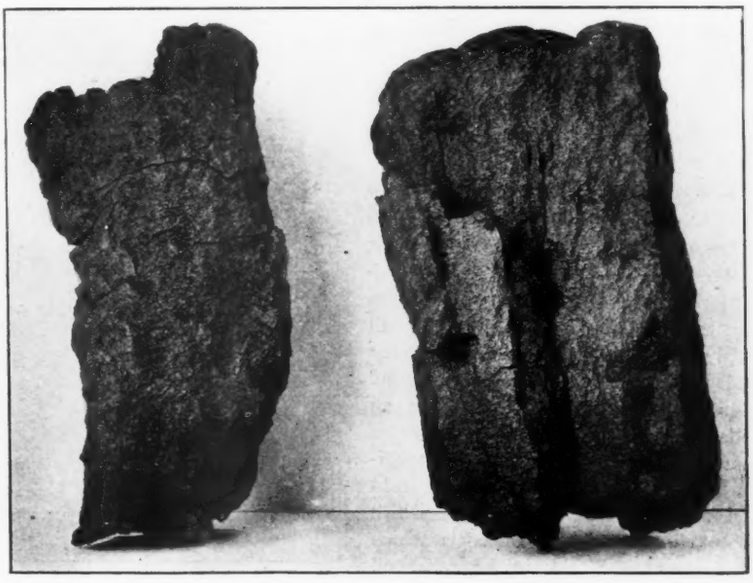


Fig. 10—Two pieces of foundry coke. The one to the left is made of 60 per cent high volatile Pittsburgh coal and 40 per cent New River on 24-hour coking time. Note that the coke made with this coal gave a great deal of cross fracture. It held together well and stood a fair shatter test. The coke to the right is made from 35 per cent Pittsburgh coal, 30 per cent high volatile gas coal and 25 per cent New River, coked under the same conditions as the piece to the left. The one to the right shows less cross fracture and it is a better quality of coke, although dense. The addition of the 30 per cent high volatile gas coal has eliminated a great deal of cross fracture.

sult in either overcoked coke in the narrow oven or a much undercoked coke in the wide oven.

Coal as received from the mines is usually what is known as run-of-mine coal. This contains some tramp iron which is lost in the mines, pieces of slate falling from the roof of the mine, sticks, *sulphur balls* or iron pyrites in various forms, etc. This coal which varies in size from dust up to lumps a foot or more in diameter, is placed on belts when received at the plant and is conveyed to what is known as the breaker and cleaner. The breaker used at the Providence plant consists of a large drum approximately 12 feet in diameter and 14 feet long. The shaft on which the drum rotates is on a slight angle, the coal inlet end being slightly higher than the refuse discharge end. The shell of the drum is perforated steel plate and inside of it are lifting plates, which lift the coal to the top of the breaker, allowing it to fall on the screen plates below. This fall breaks the coal, allowing it to pass through the 1½-inch perforations into a hopper below. Any tramp iron or exceedingly hard coal, sulphur balls, stones, slate, or other refuse gradually is worked to the lower end of the breaker, where it is discharged into a chute which leads to a bin. This breaker is housed in a steel casing which keeps in the dust. It is operated at approximately 12 revolutions per minute.

The coal, after passing through this perforated screen plate, falls into either one of two bins. One bin is used for high volatile coal; the other for low volatile coal.

Directly below these bins are located two mixing belts, which are moved at different speeds, one approximately twice the speed of the other. The coal is fed onto the belts and the height of the coal streams on the belts regulated by

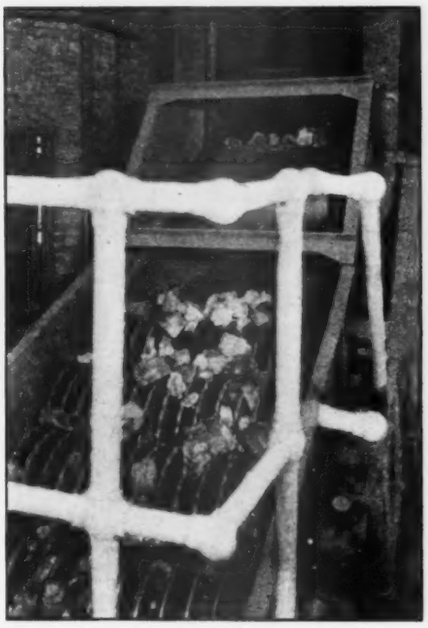


FIG. 11—A SERIES OF ROTATING DISKS CONSTITUTE THE GRIZZLY OR AUTOMATIC SCREEN WHICH SEPARATES FINE PARTICLES FROM FOUNDRY GRADES

gates. This gives the right proportions of high and low volatile coals required to secure the proper qualities in the coke.

This machine is equipped with an electrical device, by which the belts are stopped if the coal *hangs up* in one of the bins or if one of the coal bins becomes empty. In this way, the correct coal mixture always is obtained.

From the mixing belts, the broken coal falls directly into what is known as a *hammer crusher*. As it falls into the chute leading to the crusher, it is retarded by a paddle feeder, which allows only a certain amount of coal to pass into the crusher at one time and insures a steady and uniform supply.

The crusher consists of a row of steel bars or hammers, as they are called, fastened to disks which are mounted on the shaft of the crusher. These disks and hammers revolve at about 800 revolutions per minute and drive the coal through a perforated steel screen. The perforations are approximately ¾-inch in diameter. The perforated screen can be raised or lowered so as to bring it nearer to or remove it farther away from the edge of the hammers, and in this way increase or decrease the pulverizing effect.

The crusher will pulverize the coal so that 95 per cent of it will pass through a ⅛-inch square mesh sieve, and any ash which the coal may contain also is pulverized thoroughly and, therefore, the ash is put in a condition whereby it will tend to strengthen the cell wall instead of to decrease the strength of the coke.

After passing through the hammer crusher, the coal is delivered upon belts, which carry it to the prepared coal bin directly over the ovens. From this bin the coal is drawn into a motor-driven charging larry, which carries four steel funnel-shaped hoppers. These hoppers are moved into position across the top of the oven which is to be charged and coal is dropped into the oven through gates directly beneath. The charging equipment is shown in Fig. 2.

The coke plant of the Providence Gas Co. is one of the most modern. It is composed of 40 Koppers combination, cross-regenerative, coke ovens complete with the latest and most modern

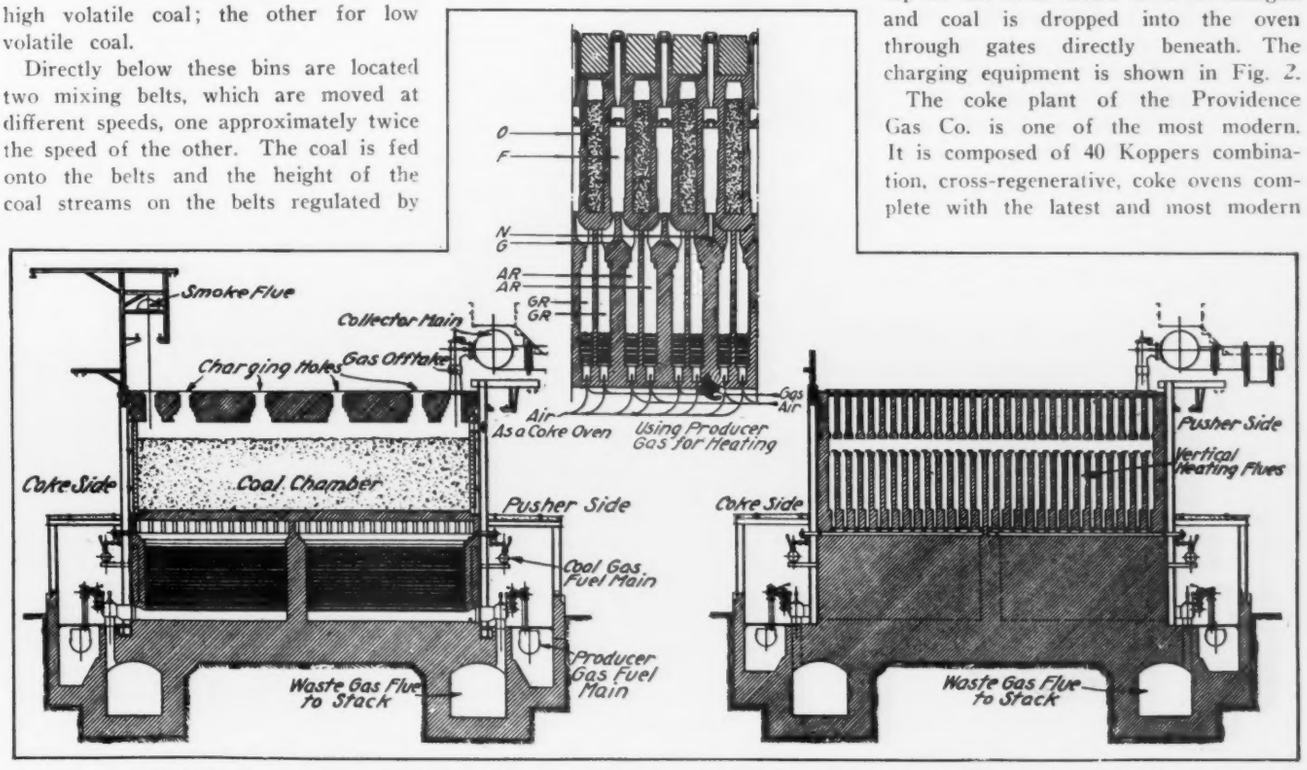


FIG. 12—AT THE LEFT IS A SECTIONAL VIEW THROUGH THE COAL CHAMBER—AT THE RIGHT—A SECTION THROUGH THE HEATING CHAMBER. ABOVE—CROSS SECTION OF A BATTERY OF OVENS

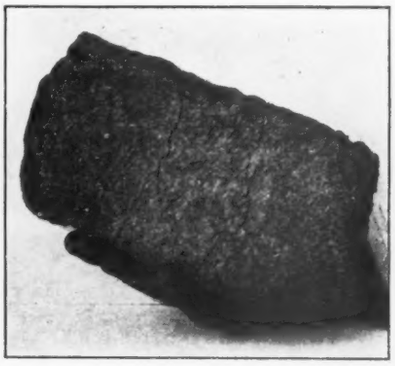


Fig. 13—Above—Coke made with a mixture of 65 per cent high volatile gas coal and 35 per cent New River on 19-hour coking time. Note that the coke is blocky. It has a cross fracture which seems to divide the coke into three sections. Nevertheless this fracture does not extend through the coke and it held together well.

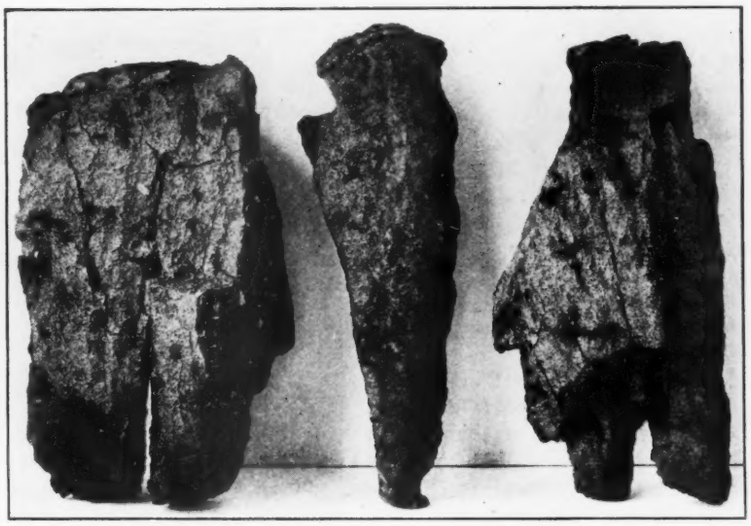


Fig. 17—Above—Coke made from a mixture of 70 per cent high volatile gas coal and 30 per cent low volatile New River coal. The heats in the ovens were too high with consequent fingery structure of the coke and irregular cell walls.

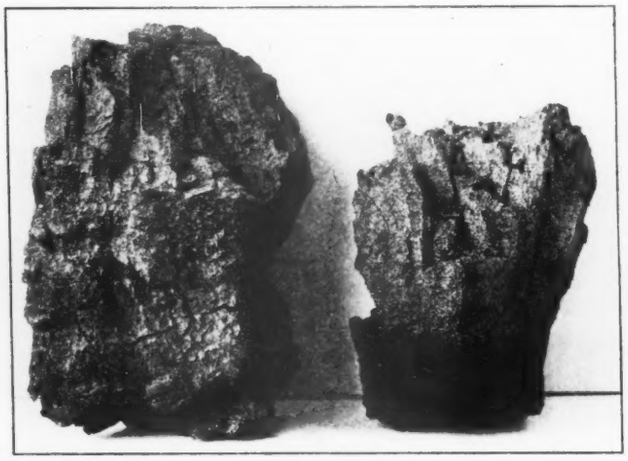


Fig. 14—Above—A piece of coke broken in two to show the irregular cross fracture obtained if the heats are too high and the coal mixture is not correct for the heat used.

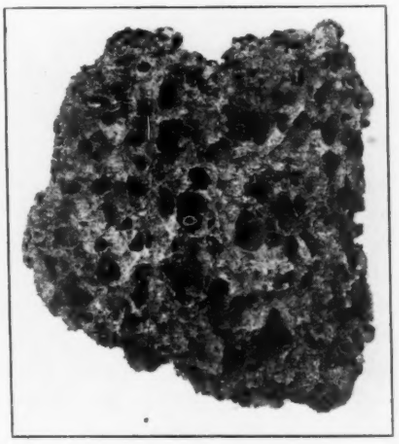


Fig. 18—Right—The coke sponge formed in the oven when a high volatile coal is coked or the coal mixture contains a large percentage of high volatile coals and when the oven is hot. Some coal mixtures when coked in one width of oven will have a great deal of sponge, while if coked in a different type of oven the sponge will practically be eliminated. These pieces of sponge all have to be picked from the belt as the coke is being loaded into cars; otherwise the percentage of breeze in the car will be extremely high.

Fig. 15—Left—The result of using a high ash coal which has not been pulverized. To make the resulting coke show the effect of a high ash coal and no pulverization, a small amount of anthracite buckwheat screenings was added to the coal. Anthracite in coke gives the same results as ash. Note that wherever a piece of ash is seen in the coke, a fracture is started. If this piece of coke were dropped 4 feet it would break into very small particles.

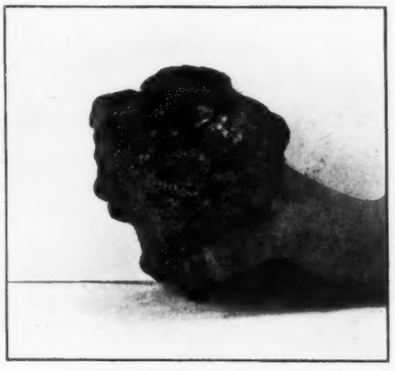


Fig. 16—Right—The wall end of coke of the same quality as that shown in Fig. 13, above and at the left.

equipment for handling and preparing the coal and finished product. The ovens each have a capacity of 11.4 tons of coal and, as they are designed for 15-hour coking time, it brings the total carbonizing capacity up to about 750 tons of coal per day. This figure can be increased somewhat if necessary, as tests have shown that the coking time can be less than 15 hours.

The ovens are 37 feet long inside, face to face of doors, and have an average width of 17 inches. The total depth of the oven chamber is 9 feet 10⅝ inches. The depth of the coal charged is about 9 feet. The oven has a capacity of approximately 460 cubic feet.

The heating walls of the ovens are built of silica brick, which offers the best heat transfer. The face walls of the ovens are clay brick, as is the floor and the larger part of the checker brick in the regenerators. At the ends of the battery are two concrete pinion walls, which hold the ovens in place. These pinion walls are built monolithic with the oven pad, so that longitudinally the battery is set in a concrete box with the sides and top removed. These end pinion walls also are held together at the top by long tie rods. The oven faces are held in place by buckstays set in the concrete at the base and are held together at the top by cross tie rods.

Combination Ovens Used

The ovens are designed to burn either coke oven gas or producer gas as fuel or, if necessary, a combination of the two gases. In the summer, with a big demand for foundry coke and a demand for gas below that which the ovens will produce in turning out the required coke, the producer plant will be practically inoperative and coke oven gas, after it has been cleaned, will be returned to the battery for heating. Reverse the condition, 100 per cent gas is made to meet the demand and the excess coke is used in the producers.

Fig. 12, at the right, shows a vertical cross-section through the center line of the heating flues. The D-shaped mains located in the trench on each side of the oven are used for producer gas. The small round main located just above the producer gas main is for returned coke oven gas. The waste heat flues are located partly under the regenerators on each side of the ovens. The air boxes or a combination of air and gas box lead from the bottom of the regenerator into the waste heat. Their functions will be explained later.

There are 30 heating flues, each of which is connected to the regenerator below it by a separate port. The coke oven gas gun is connected into the bottom of each one of these flues by a nozzle. The regenerators are divided in the center, as are also the coke oven gas flues. A horizontal flue is located at the top of the vertical heating flues. The openings between the horizontal flue and the vertical flue can be adjusted by the small sliding bricks as shown. These sliding bricks can be so arranged that a uniform distribution of heat is obtained throughout the entire length of the battery.

Adjusting the Gas

Gas is allowed to burn only on one-half of the battery for half an hour. The valves and dampers are set as follows, with gas burning on the pusher side: The waste gas flue to the stack on the pusher side is closed by the stack reversing damper. The coke side is open. This puts the suction on the coke side of the battery. The air valves on top of the air boxes which connect the bottom of the regenerator to the stack flue are open on the pusher side. The gas cocks are open on the pusher side, allowing the gas to enter the gas gun, then pass through the nozzles to the base of the heating flues on the pusher side. Here the gas meets the air which has been drawn through the opening in the top of the air box into the regenerator, where it becomes heated, and burns up through the vertical flues. Just enough air and gas is allowed to enter the flue to give complete combustion in the vertical flues, no combustion being allowed in the horizontal flue. The waste gases or products of combustion pass along the horizontal flue down through the vertical flues on the coke side, through the regenerator, where they heat up the checker brick, and through the air box on the opposite side (the damper on the top of which is closed) and then into the waste gas stack flue to the stack. At the end of the half-hour period, the dampers are reversed and the gas is burned on the coke side.

Fig. 12, at the left, shows a longitudinal cross-section through the battery. This shows the regenerators underneath the ovens, the heating flues and coke chambers.

When producer gas is used, each alternate regenerator is used for air or gas and each regenerator is divided by a thin wall. This thin wall facilitates the adjustment of the air into the heating flues on each side of the oven chamber. By this arrangement there is a heavy wall between the regenerator which has producer gas in it and the regenerator which contains coke oven gas. Producer gas, having a low heating value per cubic foot, must be regenerated before it is burned in the heating flues in order to obtain the best results. When heating with producer gas, the process is similar to that of coke oven gas with the exception that the air boxes which lead the producer gas into the base of the regenerators have an additional damper, which closes the passage between the air box and the waste gas flue, and the dampers on top of these air valves are bolted down. The air valves used for the air are the same as when coke oven gas is used.

The upper drawing in Fig. 12 shows a cross section through the regenerator and the coal chamber. It shows charging holes through which the coal is dropped, collector main at the right side and the offtake pipe which leads the gas from the top of the coal chamber into the collector main.

The air and the gas entering the heating flues may be adjusted to obtain a short flame or a long flame, thereby this area of heating can be raised or lowered, so as to keep the bottom of the oven hot with the top cold, or the flame can be gradually raised so as to place the point of heat application at any desired point. By adjusting the sliding brick at the top of the flues, if the center of the oven shows cold, more gas and air can be drawn through the flues opposite the cold part and the heats of these flues thereby made equal to that in the remainder of the flues. Therefore, it is obvious that with this type of oven, the regulation of the heat always is under the control of the operator.

Cooled at the Top

The location of the horizontal flue below the top level of the coal insures a cool top and, therefore, a maximum by-product recovery from the gas is obtained.

Fig. 2 shows the top of the ovens and the standpipes which lead the gases from the ovens into the collector main. Fig. 3 shows the combination pusher, leveler and door extractor. This machine is used to level off the coal after it is dumped into the oven. This leveling is necessary to provide a space above the top of the coal which allows free passage for the gas away from the coke. A heavy ram is used to push the coke out of the oven. This ram is about 70 feet long and passes through the entire length of the coking chamber. The door extractor is used to lift the door from the oven previous to pushing the coke out.

The coke in the oven after the door has been removed ready for pushing is indicated in Fig. 4. Note the parting line at the center of the oven. The coking process will be explained later and the reason for this parting line given at that time. Fig. 5 shows the

coke side of the ovens, the door machine in the act of taking off a door and the coke guide which is placed in front of the oven to be pushed to confine the coke as it is pushed across the bench. This also shows the quenching car ready to receive the coke as it is pushed out of the oven. An electric locomotive is used to convey this car from the ovens to the quenching station and back again to the coke wharf, which is shown just to the left of the picture at a point just opposite the electric locomotive. The gates shown in Fig. 6 hold the coke on the wharf and when open allow the coke to slide onto a feeder, which feeds the coke upon a belt. The belt, in turn, leads the coke to the foundry screening station, where a rotary grizzly or screen, consisting of disks, spaced 2½ inches apart, rotating on a shaft, convey the coke across, allowing the small particles to drop between the disks. Only coke which is larger than 2½ inches in diameter passes over this grizzly. Fig. 11 shows the grizzly in action.

The Coking Process

As stated previously, the walls of the coal chamber are heated by burning gas in the heating flues and this heat is transferred through the wall and into the coal which has been charged into the oven. When the coal touches the hot wall, it starts to melt. It does not burn, but melts forming a tarry, pitchy mass, approximately ½-inch in depth. This tarry mass seems to insulate the coal in the center of the oven from the heating wall. Further heat being applied to this tarry mass boils it and the boiling drives off the volatile matter, leaving behind the coke. This, as has been explained before, is due to the resinous, humus and carbon constituents of the coal. As further heat is applied this tarry partition moves in toward the center of the oven. The gas being driven off passes through the coke which has been left behind and the hydrocarbons passing the heated coke deposit more carbon onto the coke cell walls.

This process tends to build up the cell wall and, therefore, on a long coking time, the walls are thicker but softer. On a short-coking time, the walls are thinner but somewhat harder, due to the difference of the deposition of the carbon on the cell walls. This process takes place until the tarry masses meet in the center of the oven, completing the coking of the coal charged. This parting line was visible in Fig. 4. The speed at which this tarry partition travels inward varies with the heat application and also with the width of the oven. The rate is somewhat less than ½-inch per hour or a total coking rate of less than 1 inch per hour. On some of the modern ovens, this time has been shortened quite a good deal.

When the coke is pushed from the oven and slides into the quenching car, it is red hot and must be quenched or it will burn, due to coming in contact with the air. The car of hot coke is pushed under the quenching station, where approximately 5000 gallons of water is dashed over the entire mass.

Just enough water is sprayed on the coke to quench only the outside, leaving the inner part hot. The larger pieces of coke, if broken open just after quenching, will be found red hot on the inside.

After quenching, the car is allowed to stand a few minutes to drain off the excess water and then the coke is hauled to the coke wharf. On the coke wharf, the coke is allowed to stand for a few minutes while the excess water is driven off of the outside of the coke by the heat which is still retained in the center. With this method of quenching, coke may be obtained with less than ½ of 1 per cent moisture. However, care must be taken not to underquench the coke, for should it be loaded very soon after it is placed on the wharf, some of the larger particles may break in two in passing into the railroad car, exposing the red hot center to the air, and thus start a fire in the car.

Foundry coke that had been quenched properly was left in the storage pile over a year, exposed to rain, snow and ice. This coke when analyzed was found to contain only 6 per cent moisture. If coke is quenched until it is cold, the inner cells will draw in water which cannot be driven off by air drying, but if quenched as above, the inner cells will be dry, and if submerged in water will not absorb water and, therefore, it will dry readily if exposed to the air while in storage.

A good metallurgical coke will have a metallic ring to it unless it contains a large number of cross fractures.

In a cupola it is desirable to burn the coke to carbon dioxide (CO_2) as fast as possible; combustion to take place where it is in contact with the iron. In theory, if too small a coke is used, a great deal of carbon monoxide (CO) will be formed in the upper part of the charge by the action of the carbon dioxide (CO_2) on the carbon of the coke in the upper part of the charge. This carbon monoxide (CO) which is generated passes up through the cupola and will burn at the top with a bluish flame. This condition also arises when the coke used is too soft. Excess of blue flame at the top of the cupola then indicates one of two things: too small a coke or too soft a coke or possibly a combination of both. Excess of blue flame is actually a good indicator of losses due to the formation of too much carbon monoxide (CO).

If large pieces of coke are used in the bottom of the cupola, the surface exposed to the air for combustion will be greatly reduced, and the efficiency of the cupola will be reduced, as the rate of combustion is slower than it would be with smaller pieces of coke.

If the coke is soft, naturally large pieces must be used to carry the burden, but if the coke is of the correct structure, smaller pieces can be used, which will give greater surface and, consequently, better efficiencies.

There is another point with respect to the large coke. These large pieces or blocks of coke all have points, corners and loosely connected particles attached to them, and when coke of this kind is dumped from the car to the storage yard, transferred from the storage yard to the foundry and then dumped from the charging floor into the cupola, these smaller particles are knocked off and are practically lost as far as fuel for the cupola is concerned. Care must then be taken to obtain a good, fair sized coke of a firm texture, free from fingery structure.

Teaching Management

The Pennsylvania State College, State College, Pa., will hold its summer course in Industrial Organization and Management, Aug. 9 to 15. This year will be the fifth consecutive session of the course. The purpose of the instruction is to assist men in the development of their positions, to broaden their vision of the possibilities of the science of management, and to illustrate to the student by practical examples the most effective methods of modern organization.

Starts New Furnace

Steel now is being melted by the Black Steel & Wire Co., Kansas City, in a 10-ton open-hearth furnace with a maximum output of 30,000 pounds, installed by the McLain-Carter Furnace Co., Goldsmith building, Milwaukee. The steel is being poured in 4, 6 and 8-inch ingots for rolling into rods. It is expected that the 4-inch ingots, after being cast will be rolled into rods with only one heating. The Black Steel & Wire Co. specializes in the manufacture of wire, wire rods, etc.

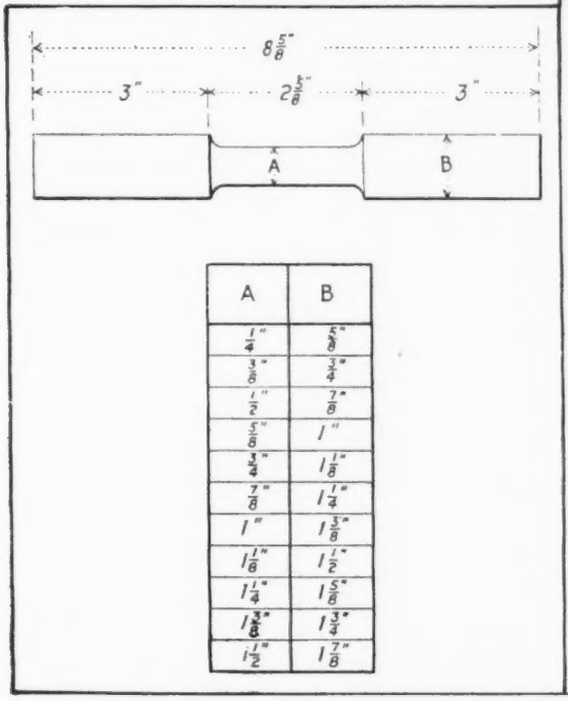
R. K. Morse recently has been appointed western manager for the Milwaukee Electric Crane & Mfg. Co., with offices in the Pittock block, Portland, Oreg.

Variables Bias Malleable Tests

The Relation Between the Tensile Strength and the Percentage of Elongation and the Diameter of Rough and Machined Specimens is Shown in Graphically Expressed Data

BY H. A. SCHWARTZ

THAT machining greatly weakens malleable cast iron is a wide-spread though not necessarily correct belief. In justice to the engineer, who as a basis of design must know how nearly the specified properties may be attained in the sections he proposes to use, the reasons for this belief should be investigated. If the belief is ungrounded, it should be discredited; if it is well founded, the necessary data to prove it such should be available. When specimens of malleable cast iron of various cross-sectional areas, including both machined and unmachined specimens, are tested, a number of variable factors may influence the physical properties.



A	B
1/4"	5/8"
3/8"	3/4"
1/2"	7/8"
5/8"	1"
3/4"	1 1/8"
7/8"	1 1/4"
1"	1 3/8"
1 1/8"	1 1/2"
1 1/4"	1 5/8"
1 3/8"	1 3/4"
1 1/2"	1 7/8"

FIG. 1—DIMENSIONS OF TEST SPECIMENS AS CAST

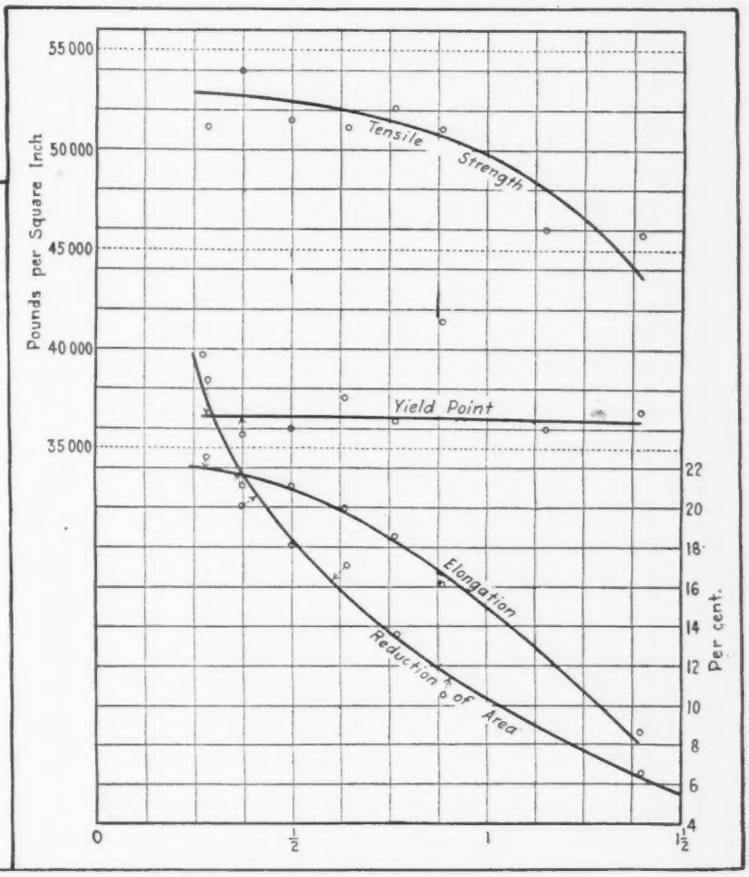


FIG. 2—RESULTS OF TESTS ON SPECIMENS GROUND BEFORE ANNEALING

For convenience in referring to these variables in the paper, they are listed and numbered below:

1 Decarbonization may strengthen the surface metal.

2 The surface metal may be stronger than that at the center, due to the effect on the grain structure of the rate of cooling in freezing.

3 Specimens of small cross-sectional area as cast may be relatively stronger from the same cause.

4 Slower cooling in the larger cross-sections may precipitate primary graphite with diastrous results.

5 The larger cross-sections may not be mechanically sound due to shrinkage. This weakens them as a whole and also weakens the center as compared with the surface.

6 The machined specimen, owing to its uniformity of cross-section, will yield apparently better results, particularly as to elongation and reduction of area, than a rough one.

A course of experiments was planned which should permit of comparisons between specimens as nearly similar in respect to five of these factors as possible in order to test the effect of the remaining variable.

It was evident early in the investigation that variable No. 5 would cause prohibitive difficulty in specimens geometrically similar to the American Society for Testing Materials specimen. Although this particular specimen is quite satisfactory in the size called for in the specifications, in sizes much larger or much smaller, as would be the case in the wide range covered in this investigation, specimens geometrically similar would not be satisfactory. Preliminary experiments were therefore conducted to determine the best design of specimen, gate and feeders to insure soundness. It was assumed that the design producing from a given metal the strongest and most ductile bars with the least variation as between triplicate specimens was that most conducive to soundness. About 3500 bars from some 500 heats were broken in the course of a preliminary investigation. As a result a set of speci-

Paper read by H. A. Schwartz at the twenty-third annual meeting of the American Society for Testing Materials in Asbury Park, N. J., June 22-25, 1920.

mens cast to the form and dimensions shown in Fig. 1 was decided upon and gated as the results of the preliminary test indicated as best. Variable No. 5 is thus eliminated from consideration.

From this pattern equipment, a number of specimens of each size were cast from metal of the following composition: Carbon, 2.44 per cent; silicon, 0.76 per cent; manganese, 0.180 per cent; phosphorus, 0.166 per cent; and sulphur, 0.099 per cent. Examination of the largest specimens disclosed the absence of graphite, thus eliminating variable No. 4. The carbon content of the metal removed by machining was determined and ran from 0.09 to 0.15 per cent.

The molds were made by a highly skilled man, so that all the specimens were unusually free from surface defects. The best one of each size was set aside for use without machining. The consequence of variable No. 6 was thus minimized as far as possible, though it of course can not be entirely overcome.

One specimen of each size was then ground for its entire gage length to a diameter ⅛-inch less than its nominal diameter as cast. This involved the removal of a little over 1/16-inch of the surface metal in most cases.

The set of specimens originally reserved, the ground set and an additional rough set were then annealed under conditions which assured the greatest possible uniformity throughout the series. After annealing, the ground specimens had, of course, increased about one per cent in diameter. The third or rough set of annealed specimens was then turned to the same diameters as the corresponding members of the series that had been ground to size. The two finished series were thus exactly similar to each other except as to the effect of the first variable. The series ground to size before annealing was exactly similar to the unmachined series, except as to the effect of the second and third variables, which are related, and some residue of the effect of the sixth variable which could not be completely overcome. Each series within itself was alike, except with respect to the third variable. An intercomparison of data from the three series should therefore permit of conclusions as to the relative effect of the first three variables.

The study of the gating problem and the production of acceptable specimens was the most difficult part of the problem, occupying about six months of experiment.

The specimens were tested in tension. The results obtained are shown graphically in Figs. 2, 3, and 4. In the absence of a suitable extensometer, the yield point was determined by the divider method; so the results are none too accurate. Determination of the reduction in area of unmachined specimens was omitted for it was considered unsatisfactory.

The tests show clearly the decrease in strength and ductility with increasing area of cross-section and show also that decarbonization somewhat improves the material, mainly in ductility. The fact is also brought out that the surface metal, as cast, irrespective of decarbonization, is superior to the interior metal. It is further shown that these differences, though well defined, are not so great as to warrant the old assumption that malleable iron owes all its virtues to the decarbonized skin.

It can be shown that the graphs given are nearly equivalent to the equations shown in the table on page 529 in which d is the diameter in inches of the specimen as tested.

Within the limitations of accuracy of the method used for its measurement, the yield point may be said to be nearly constant. Comparison of the reduction of area is omitted, first because the determination can not be made on cast specimens, second because the two graphs do not follow curves of similar equation, and third because the determination is not commercially applied to this product. The tensile strength of rough specimens and the elongation of specimens machined after annealing depart somewhat more from the calculated values than the other data.

The effect of decarbonization alone

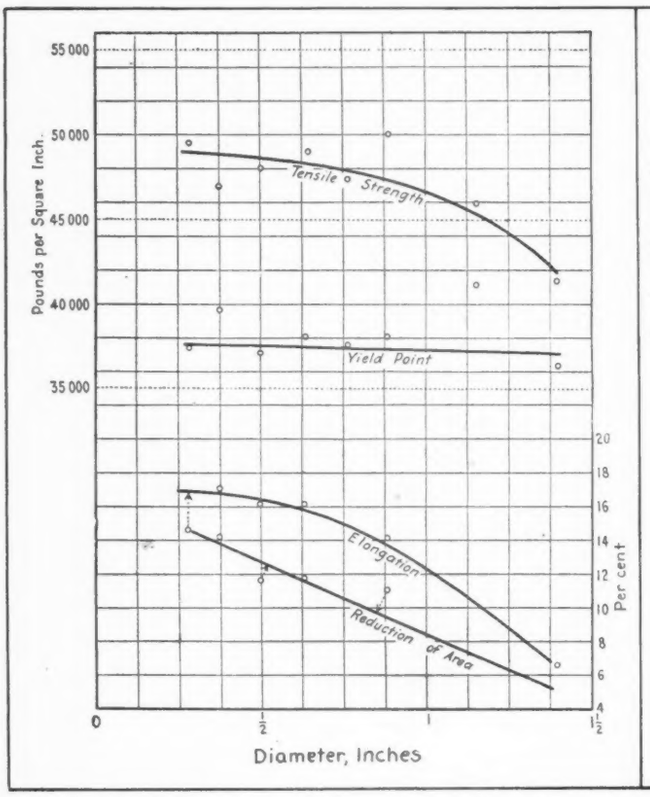


FIG. 3—RESULTS OF TESTS ON SPECIMENS TURNED AFTER ANNEALING

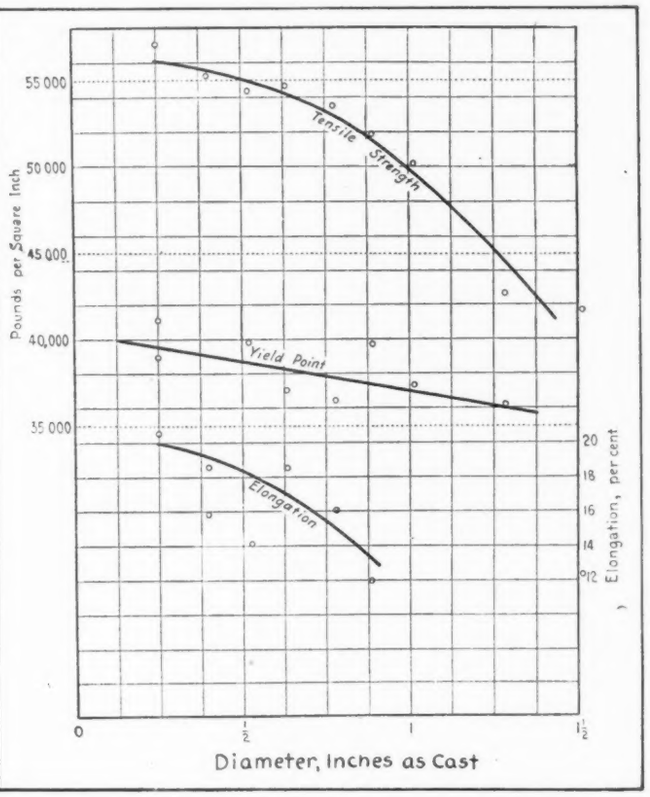


FIG. 4—RESULTS OF TESTS ON SPECIMENS NOT MACHINED

on tensile properties may be obtained by subtracting equation 3 from equation 2 and is a decrease of 4000—789 d^3 pound per square inch in tensile strength and 5—029 $d^{2½}$ per cent in elongation An attempt to compare equation 1 with equation 2 must include considerations of the fact that specimens of diameter d in equation 2 had a diameter $d + 0.125$ in equation 1. The graph for tensile strength plotted from equation 1 intersects that plotted from equation 2 at a value of d (as cast) of about 0.9 per cent. Thus, a bar annealed with its original surface is stronger than one annealed after grinding if the original diameter is less than 0.9 inches, and weaker if the diameter is greater. The variation is from 2700 pounds stronger to 3200 pounds weaker in the range investigated. The elongation

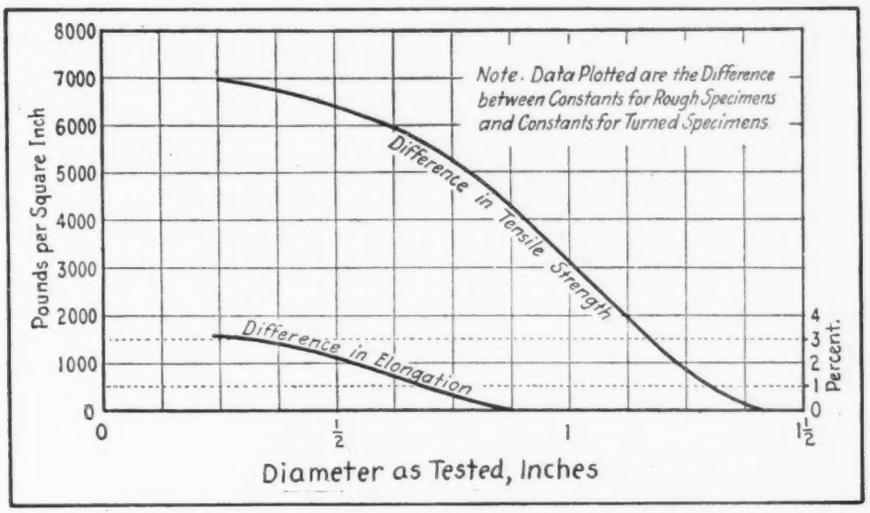


FIG. 5—COMPARISON OF TENSILE PROPERTIES OF MACHINED AND CAST SPECIMENS OF EQUAL DIAMETERS

is always less for a cast specimen, the range being from 2 per cent less at a diameter of ¼ inch to 5 per cent less at a diameter of 1 inch.

The crossing of the two graphs for tensile strength is of course due to the superimposing of two effects, that of the chilled surface which is beneficial and that of the rough surface which is harmful. The former predominates in small, the latter in large specimens.

For the use of the designer, the difference in strength and elongation of specimens cast to size and of specimens machined to the same size is summarized in Fig. 5.

The exact numerical data in the present experiment hold true, of course, only for the particular metal and heat treatment involved. Some generalizations are, however, probably justified and may lead to the following conclusions of general application:

1 Decarbonization has a favorable influence upon the strength and ductility of the product.

2 The effect of quick cooling in freezing on the surface metal of a casting is such as to improve the strength and ductility of the product.

3 Roughness of surface of a cast specimen apparently decreases the strength and especially the ductility.

4 The ultimate strength decreases with increasing diameter of section by an amount proportional to the cube of the diameter.

5 The elongation decreases by an amount proportional to the 2½ power of the diameter.

6 The combined effect of all three of the preceding variables on strength amounts to about 7000 pounds per square inch for sections ¼ inch in diameter or less, and becomes negligible at diameters of 1¼ inch or over.

7 The combined effect on elongation is about 3 per cent for small specimens and negligible for diameters above ¾ inch.

8 The yield point is apparently not affected by any of the variables investigated.

	Tensile Strength, lb. per sq. in.	Elongation in 2 in., per cent
(1) Unmachined	56,000—5,384 d^3	20—8.01 $d^{2½}$
(2) Machined before annealing	53,000—3,231 d^3	22—6.58 $d^{2½}$
(3) Machined after annealing	49,000—2,462 d^3	17—6.29 $d^{2½}$

Appoints New Secretary

W. Hollingsworth, formerly secretary of the British Society of Heating and Ventilating Engineers, has been appointed general secretary of the Institution of British Foundrymen, to fill the vacancy caused by the resignation of Capt. Alexander Hayes. The appointment was made at a meeting of the general council held in York recently, and is subject to confirmation by the members.

The main office of the Institution of British Foundrymen is at Bessemer house, Adelphia, London W. C. 1, where the secretary has his headquarters.

Mat Riddell, member of the firm of Watson Gow & Co., ironfounders, Falkirk, Scotland, was nominated for the office of president by the general council at the same meeting. The election will take place at the annual convention which will be held at Glasgow Aug. 27, 28 and 29.

The Institution of British Foundrymen has been granted a royal charter which it is hoped will be completed in time for the meeting in August. The steady growth of the society continues and the membership approaches 2000.

Acquires Ring Plant

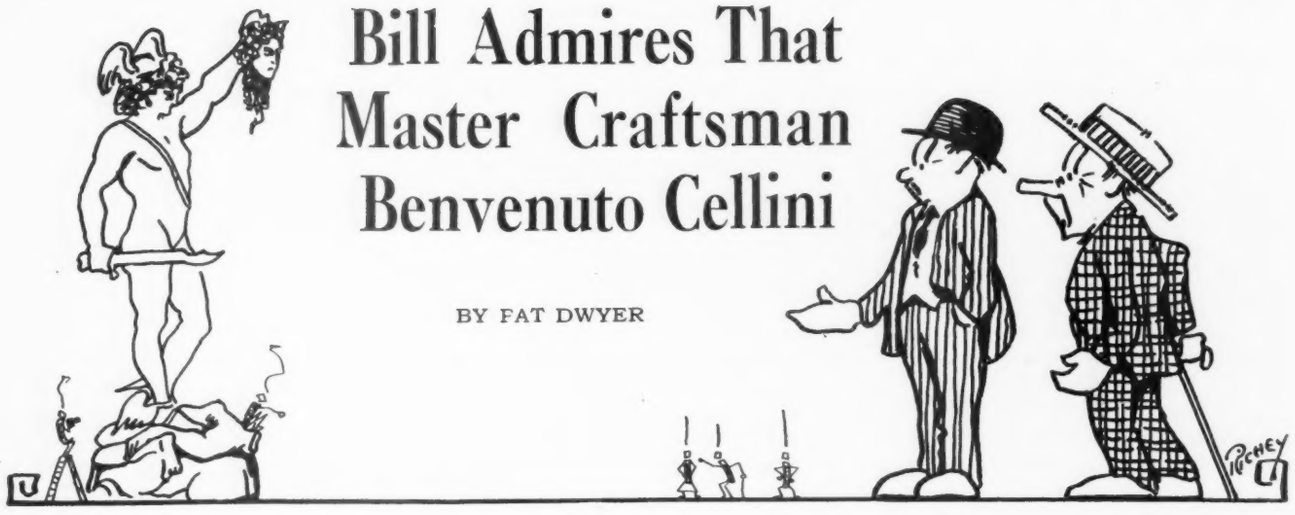
The Detroit Piston Ring Co. has purchased the Plymouth, Mich., plant of the National Foundry & Machine Co., Ypsilanti, Mich., and will operate under the name of the Detroit Ring Casting Co., Plymouth, Mich. The foundry will employ 40 molders, specializing on rings which will be machined at the main plant, Detroit.

Consolidates Interests

The Gillespie Mfg. Co., Gillespie Motor Co., Broker-Eden Co. and the Gillespie Foundry Co. have consolidated under the name of the Gillespie Eden Corp. to produce washing machines and all the component parts required. The officers are T. H. Gillespie, president; F. J. Nash, secretary, and H. S. Hart, treasurer.

The Racine Furnace & Foundry Co., Racine, Wis., recently has been formed from a reorganization of the Osborne Casting Co., of that city. Capital stock of the company has been increased to $60,000. The officers of the company are Charles G. Holmes, president; John H. Osborne, vice president, and William F. Stremke, secretary.

The Lycoming Foundry & Machine Co., Williamsport, Pa., has changed its name to the Lycoming Motors Corp. and under this designation will continue the manufacture of automobile motors.



Bill Admires That Master Craftsman Benvenuto Cellini

BY FAT DWYER

IF WE were to believe all we hear, which indeed would be a calamity, we could trace all our actions and physical characteristics to hereditary influence. Some learned authorities claim that we inherit everything from the color of eyes to wooden legs from our ancestors. Other equally learned and spectacled gentlemen are inclined to hedge a little and hesitate to give their unqualified approval to such items as peg legs, false teeth and glass eyes. They never hesitate to rush into print on the slightest provocation, airing their views on the subject. In justice to these learned savants it must be admitted that they are wise in their generation and always preface their remarks by one of the two standard phrases which are always left standing in all well regulated newspaper offices: "It is claimed on competent authority," or "It has been stated by those in a position to know."

I have always been inclined to doubt the hereditary theory. None of my ancestors, so far as I have been able to gather from a diligent perusal of *Burke's Peerage* or *Who's Who* to say nothing of that other standard work *Vich is Vich*, ever so much as saw the inside of a foundry. Yet I drifted into the business at a tender age and absorbed foundry lore, plumbago dust and sulphur fumes from open salamanders as naturally as if my remote ancestors had been accustomed to grubbing castings out of the sand every morning instead of wearing the hair off their toes grubbing potatoes out of the soil of the "Old Sod."

The clinching and final point against heredity lies in the question of clothes. When I was a little boy I used to get a new suit ever so often—not to be too specific. Now that those days have gone by and I am become, thanks to my foundry training, indifferent to the opinion of others on the subject of clothes, I don't mind admitting that I then had a gentle, bashful and retiring disposition. I suffered agonies on the first few occasions on which I wore a new suit, even from the comments of friendly disposed acquaintances who commented on the quality, style and price of the apparel. I would take a round-about way to church and school. When I approached them in the morning or my own house at night I would scuttle in at the door like a rabbit.

Now if there was anything in this heredity theory, bashfulness and a retiring disposition should be a prominent characteristic in my children. But is it? It is not! When they get new clothes they do not care who knows it. The novelty of being decked out in new and shining raiment may have some bearing on the question but I think that evidence may properly be ruled out as being irrelevant to the subject at issue. One lusty young hero who is 5 years old and therefore in a position to form his own opinion on nearly any subject found himself trimmed up last Sunday in a new suit which included braces and pockets in the pants. Our immediate neighborhood was too restricted an area to do justice to such magnificence and he suggested that I would be conferring a favor on mankind in general if I should take him for a stroll in the park. I assured him that nothing would give me greater pleasure than to accompany him and shine to a limited extent in his reflected glory.

We strolled in the park for awhile and then sat on one of the steps of the art museum in the vicinity of Rodin's bronze statue, The Thinker, a gentleman who as you know wears no clothes. I was idly speculating on what he probably was thinking about, when Bill came down the steps and took a seat along side us. I asked his opinion of what our bronze friend was turning over in his mind. Bill said that probably he was congratulating himself that he did not have to shoot his whole pay check every month for enough clothes to pass muster with the rest of the Willies.

"'Tis a fine piece of work, though," said he. "Do you know whenever I see one of these big statues I regret that I never had the opportunity of working in one of those old European foundries where they made that kind of castings. A short time ago I read the biography of one of the most famous of the old birds connected with the foundry industry, Benvenuto Cellini and, say, he certainly was a master craftsman. The book, of course, was a translation from the Italian and I am afraid the translator had a better knowledge of the Italian language than he had of foundry practice. He gives several of Benvenuto's questionable exploits as a bravo and gay Lothario with the minutest detail but in translating the artist's description of how he prepared the molds, melted the metal and poured the castings for some of his famous statues, for the most part he is delightfully vague and only mentions the points which would be apparent to the most casual observer. The multitude of little intimate, practical details which would appeal to men familiar with foundry practice are sadly lacking.

In only one instance does the volume treat in detail of any specific job and then the description is confined mostly to the trouble our hero experienced in melting the metal for a large figure which he had molded and then buried in the floor. From the meager details available it appears that he employed the *lost wax* process, a process by the way which is still employed extensively among manufacturers of statuary and ornamental bronze castings."

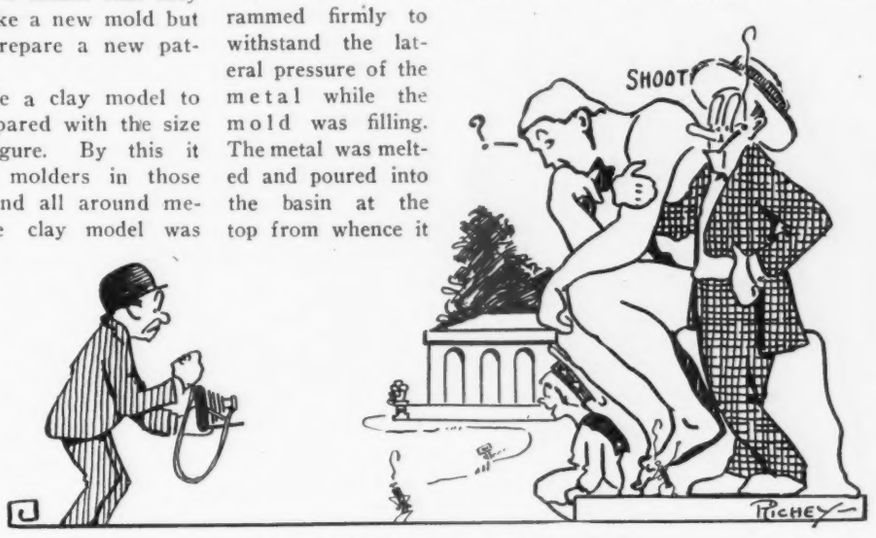
"I know all about it," I said. "I read a description of the process in THE FOUNDRY."

"I remember reading the same story you are talking about," said he. "The

illustration showed a model of a Rocky mountain sheep or a billy goat being used for a pattern. In that method you are talking about, they make a master mold out of plaster of paris and then make as many duplicates off it as are necessary. In Benvenuto's time they only made one mold and therefore if anything went wrong with the casting process it meant that they not only had to make a new mold but they also had to prepare a new pattern.

"Cellini first made a clay model to a certain scale compared with the size of the proposed figure. By this it will be seen that molders in those days were artists and all around mechanics. After the clay model was finished he welded together several pieces of bar iron to serve as a core iron. The core iron was set up on a foundation in a pit in the foundry floor and a rough core core built up bricks and loam conforming to the contour of the proposed figure. A thickness of wax equal to the desired thickness of metal was then built on the core, the outside surface of the wax being modeled to form a replica on an enlarged scale of the small clay model.

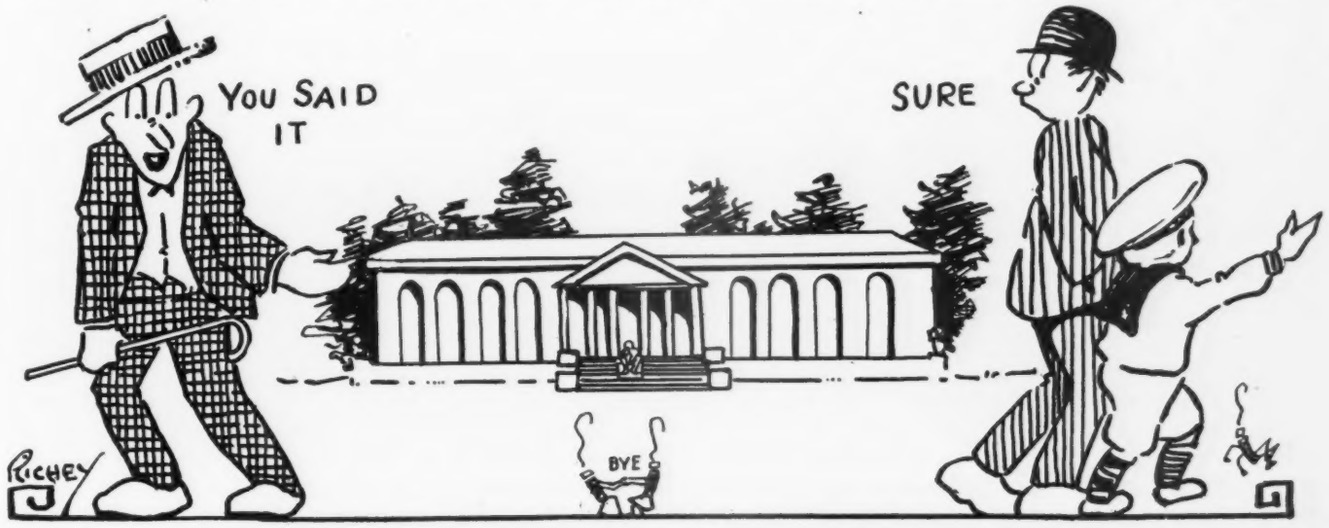
"Commencing at the bottom a thin coating of fine slurry was painted on to the wax, a coating of loam laid next to that and then a wall of brick behind that. The building was gradually carried up until the entire figure was enclosed. Wax sticks were attached at various points and carried up through the brick work all converging at the top into a common basin which was destined to receive the metal. An opening was left under the bottom communicating with the interior of the hollow core and after the mold was completed a charcoal fire was built in the opening and another fire built around the outside and both of them kept going until all the wax had melted and run out and the mold was thoroughly dried. The opening at the bottom and the pit surrounding the mold was filled with sand and rammed firmly to withstand the lateral pressure of the metal while the mold was filling. The metal was melted and poured into the basin at the top from whence it was conveyed and distributed to the different parts of the mold through the channels left by the wax sticks.



BILL IN CLOSE PROXIMITY TO REAL THOUGHT

"There was no law against overtime in those days and Ben had worked night and day on the job, with the result that by the time the mold was finished he had a high fever and was all in. He superintended charging the furnace and then went to lie down, leaving orders to be called as soon as the metal was melted. While he slept a terrific wind and rain storm arose which lifted the roof off the furnace room. The helpers sheltered themselves as best they could and neglected the fire and the metal which almost had been ready, commenced to set. His faithful old landlady aroused Ben and told him if he didn't get on the job all of his work would be ruined. Did that cure his fever? I'll say it did. He came into the foundry in two jumps raving and roaring like some of his modern prototypes, but with greater cause, and he certainly got action. He sent for all the pewter dishes in the house and threw them into the pot. He sent some of his men across the street to a bake shop where they grabbed a quantity of dry oak wood. He started a fire under the grate of his furnace, piled all the dry oak wood in it and succeeded in getting his metal liquified again. It was not in as perfect condition as he would have liked to have seen it, in fact a considerable portion was stuck to the sides of the pot. However, he took a chance, the same as molders always did and always will, and poured the casting. There was not a drop left in the basin and he was afraid he had poured the casting short but when the casting was stripped it was found to be perfect with the exception of one little place down near the bottom where the metal had been too dull to run.

"Old Ben had one characteristic which shows that molders were the same in those days as they are now. He never admitted that he lost a casting. In the case I have mentioned he admits that he *nearly* lost this one, but as a further proof of the analogy between ancient and mod-



BILL ADMIRED BENVENUTO'S VERSATILITY, AND RESPECTED HIS FOUNDRY ABILITY

ern foundry practice, he is right there with the alibi and places the blame on the furnace tender. The circumstance afforded him an opportunity to show his resourcefulness by burning a piece onto the defective part afterward and he gives this feature due prominence. Taking it by and large I think you will have to admit that the Ancient and Honorable Art shows no sign of decadence and that modern foundrymen are ably upholding the noblest traditions of the craft.

"When I read that story it carried me back a good many years to a shop I worked in where an occasional pot of brass was melted in the blacksmith forge. The molds were made in the foundry and carried to the blacksmith shop on a flat hand barrow. The pot was placed in one of the forge fires and charged with metal. Some one had to stand alongside for an hour or more and keep the coal fire built up. A second man was kept busy carrying slabs of wood to make an additional fire around and over the top of the pot. It was an expensive method but the castings were as sound and solid as any I have seen made by any process since."

"If you would kindly give me a chance to say a word," I said, "I might say that I also have read Benvenuto Cellini's biography and the only wonder to me is how he found time in the midst of his fights and his amours to make any castings at all."

"You said it," said Bill.

One-Piece Coreboxes Find Ready Favor

BY M. E. DUGGAN

CORES are projecting forms of sand, either left in the mold by the pattern itself and known as green sand cores, or made separately in a corebox and known as dry sand cores. The latter are dried before being placed in position in the mold. A dry sand core is empl yed to produce a hole or recess of a peculiar shape or in a position where it is impracticable to make the mold of the necessary conformation by the use of the pattern alone. Dry sand cores frequently are employed to modify the shape of a pattern to simplify the molding process.

Dry sand cores are composed of sand, bonded artificially and rammed in coreboxes to form the desired shape. After these cores have been baked they are strong enough to withstand considerable rough handling; but previous to baking they are so weak that they cannot be handled without being supported in some way. It therefore is as necessary for the patternmaker to know how the corebox is to be taken off the core as it is for him to know how the pattern is to be drawn out of the mold.

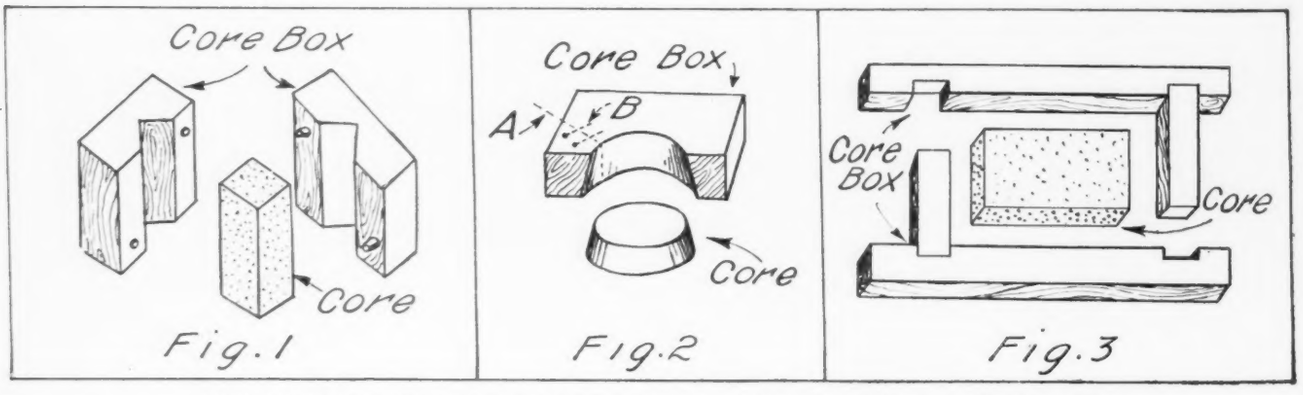
The coreboxes shown in the illustration are examples of the method usually employed. The corebox shown in Fig. 1 is made in halves and that in Fig. 3 is loose at two opposite corners. These boxes can be drawn away horizontally from the cores leaving them standing just as they were made, on an iron plate, ready for removal to the core oven.

The question often is raised: When does the method shown in Fig. 1 cease to be practical? In other words what is the greatest length of 2-inch square core that can be dried on end? I have asked this question of many patternmakers and received practically a different answer each time. No one seems to have any definite idea on the subject. How is a patternmaker to know the greatest length of core in proportion to its diameter or square that can be dried on end. For example if 6 inches is the limit of a certain diameter core for drying on end, it simply is wasting time and material for the patternmaker to make two half boxes for cores over that length.

A common method of constructing slab coreboxes is shown in Fig. 3. It is made loose at the opposite corners, is provided with checked-in joints and is designed to be taken apart before removal from the completed core. I was taught to make coreboxes as illustrated in Fig. 3 whether for cores ¼ inch deep or for cores 10 inches deep and whether one or many cores were wanted.

When these coreboxes reached the core room the coremaker invariably made one-piece coreboxes out of them by nailing the corners together. Instead of drawing the box away horizontally in two halves he drew it straight up in one piece. I learned from this that much of the work lavished on this style of corebox is unnecessary. Since learning that the one-piece corebox is practical and preferred by the coremaker I have made hundreds of them.

The usual way to make a corebox like that illustrated in Fig. 2 is to turn it out on the lathe from a solid block. In my early days at the trade I made coreboxes in that manner. However, I learned later that coreboxes of this any many other designs can be cut on the bandsaw in about one-fourth the time required to make a turned box. The piece is dressed to the required thickness, the circle struck on the face of the block, the saw table tilted to the required angle, a saw cut made on the line *A* and the center cut out to the required size. With a little sand-papering the job is finished. The joint *A* where the saw entered and came out can be drawn together and fastened with a few nails as at *B*, in Fig. 2



USUAL CONSTRUCTION OF COREBOXES DESIGNED FOR SLAB CORES AND CORES TO BE DRIED ON END

Fitting the Foundry to the Product

Established Machinery Manufacturing Company Draws From Its Past Experience in Building and Equipping New Addition For Castings Production

BY PAT DWYER

TODAY the tendency among manufacturers is to specialize as far as possible, to concentrate on one particular product, and by a system of intensive methods, scientifically applied, to secure a maximum output with a minimum expenditure of labor and expense. To secure this result it usually is found necessary to install special mechanical equipment and arrange the sequence of operations peculiar to the process so that the complete operation can be finished with the least number of motions and provide that each time the article in course of construction is worked upon it is passed along a little further toward its ultimate goal. A considerable amount of machinery is manufactured by the machine tool builders for fabricating different materials on fairly well established standard lines. The precision and accuracy of operation maintained by these machines when in use insure a large output of high grade product and incidentally reflect credit on the manufacturer who made them.

Nearly all of the firms engaged in the manufacture of power tools carry a large list of stock sizes and designs of patterns from which they are prepared to furnish machines and in addition many of them maintain a staff of engineers familiar with their particular problems who are willing and competent to design special machinery to perform almost any duty that a customer may specify.

The builders of this special machinery are placed in the rather peculiar position that while their machines enable customers to standardize for larger production, they themselves must treat each machine as a unit and proceed with its manufacture along more or less untried lines. This factor to a great extent eliminates the possibility of quantity production because many of the machines are ordered singly or in small lots of two or three units and may never be duplicated. Even in cases where the order is duplicated it is nothing uncommon to find it accompanied by instructions to make certain changes which in the great majority of cases makes it practically a new job.

Owing to these and, perhaps, other reasons, the firms engaged in special machinery work have been slow in modernizing the building and equipment in their foundry department. The great bulk of the work made in their foundries requires the services of highly skilled men and of course the principal advancement made in foundry

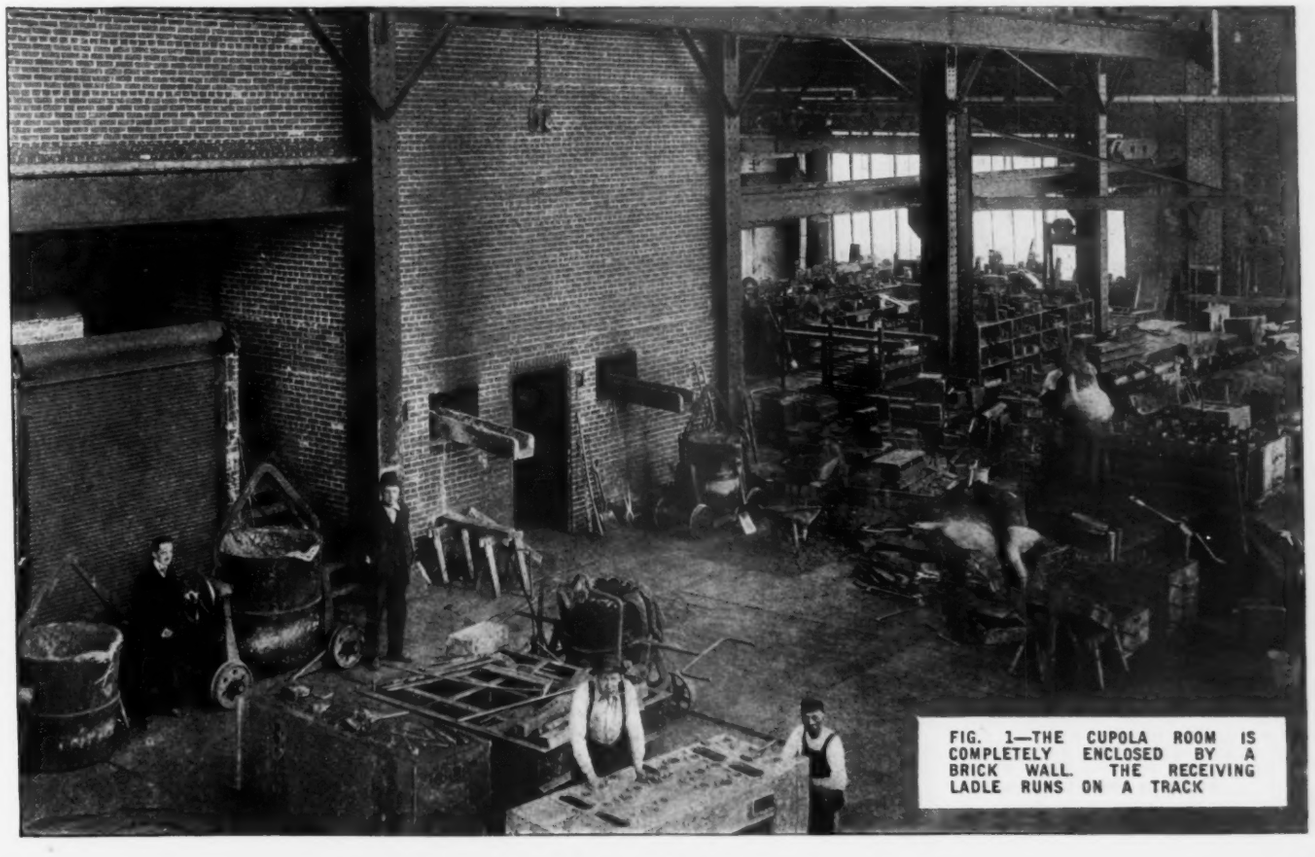


FIG. 1—THE CUPOLA ROOM IS COMPLETELY ENCLOSED BY A BRICK WALL. THE RECEIVING LADLE RUNS ON A TRACK

FIG. 2—THE LARGE FLASKS ARE MADE OF ROLLED STEEL CHANNELS WITH CAST IRON ENDS

FIG. 3—ONE OF THE TWO CONCRETE PITS INTO WHICH THE LARGE MOLDS ARE SET FOR POURING

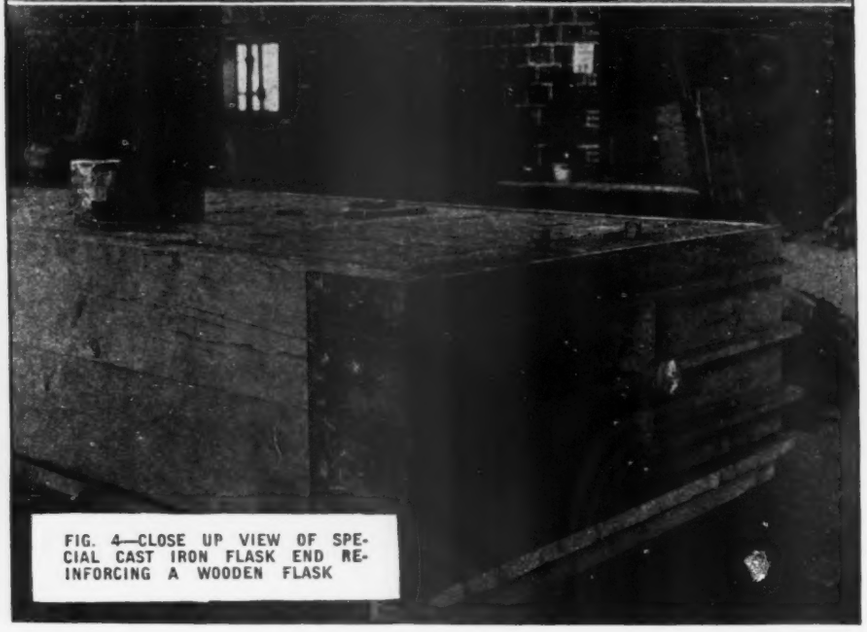


FIG. 4—CLOSE UP VIEW OF SPECIAL CAST IRON FLASK END REINFORCING A WOODEN FLASK

practice in recent years has been in devising methods to secure increased production on repetition parts with unskilled labor. The cost of installing the necessary equipment for doing that kind of work is quickly absorbed in the immense production but is entirely out of the question in a shop where the machines are ordered in units and not in thousands. However, there are some phases of the foundry problem, such as light, heating and ventilation which are common to every foundry and the improvements effected in these features in recent years may be applied with equal facility to any business devoted to the casting of metals.

A new foundry designed by and erected under the supervision of Clement A. Hardy, Chicago, recently has been placed in operation at the plant of the Defiance Machine Works, Defiance, O. The peculiar conditions incident to the manufacture of the company's product, consisting to a great extent of special wood and metal working machine tools, were taken into careful consideration when designing the building and installing the equipment. The present output is about 10 tons a day, but to allow for future increase the plant was built to function satisfactorily up to 20 tons. The building is 132 x 140 feet and as may be seen by the illustrations, consists mainly of windows outside of the end walls and the roof. Most of the sash sections are top hung and may be adjusted to promote circulation of air and help to keep the shop cool in the summer. It is heated in winter by a continuous system of steam radiators which extend around the wall at the floor level and a supplementary row high up near the peaks at the two sides of the Pond-truss roof.

General Shop Layout

The entire floor of the building with the exception of two casting pits near one end of the main bay is covered with a smooth concrete floor. All the molds made in this shop are made in flasks and rolled over and the smooth, level concrete floor is a factor in preventing the molds from warping and producing crooked castings. The building is divided naturally into three bays by the two rows of columns supporting the crane runway and the roof. The center bay is 52 feet wide and each of the side bays is 44 feet. The center bay is devoted entirely to molding and cleaning the large castings. One of the side bays contains molding floors and the chipping and grinding room while the other side bay covers the

FORMULAS FOR THE BRASS FOUNDRYMAN

ALUMINUM ALLOYS PATENTED IN THE UNITED STATES AND ABROAD

The following alloy was patented by W. A. McAdams, United States patent No. 1095653:

	Per Cent
Aluminum	70.00
Zinc	22.00
Antimony	5.00
Copper	3.00

The object in adding antimony was doubtless to control the shrinkage of the alloy.

The following alloy was patented by C. P. Van Gundy, United States patent No. 1098137:

	Per Cent
Aluminum	86.50
Zinc	9.70
Lead	2.50
Copper	1.30

The object gained by addition of lead is a closer grained alloy that will resist pressures.

The following alloy, patented by W. A. McAdams, United States patent No. 1104369, is claimed to be suitable for "hammered silverware":

	Per Cent
Aluminum	80.00
Silver	4.00
Tin	8.00
Cadmium	8.00

As manganese is frequently used in making alloys of aluminum it is interesting to note, this has been made the subject of a patent by Alfred Wilm, Berlin, Germany, United States patent No. 1130785, March 9, 1915.

The inventor states the addition of manganese is particularly advantageous when it also contains up to 2 per cent magnesium. As an example the following alloy is given:

	Per Cent
Aluminum	93.10 to 96.50
Magnesium	0.5
Copper	5.6 to 3.00

This alloy has certain properties, but the addition of as little as 0.5 per cent manganese, increases the strength about 17 per cent, the hardness, by the ball test, about 10 per cent, and at the same time the alloy is better to file and work.

FORMULAS FOR THE BRASS FOUNDRYMAN

ALUMINUM ALLOYS PATENTED IN THE UNITED STATES AND ABROAD

An alloy that is claimed to be particularly adapted to casting purposes is the subject of a patent by W. A. McAdams, United States patent No. 1146185. The following proportions are suggested:

	Per Cent
Aluminum	82.00
Copper	12.00
Cadmium	5.00
Silver	1.00

In United States patent No. 1156093, Charles Pack protects alloys of aluminum adapted for die-casting purposes. Two alloys are suggested as follows:

For small, simple castings:

	Per Cent
Aluminum	91.00
Copper	9.00

The inventor finds it desirable and necessary to increase the percentage of copper as the castings increase in size and become more complicated. The highest percentage of copper he has been able to use successfully, follows:

	Per Cent
Aluminum	80.00
Copper	20.00

The addition of iron to aluminum alloys also is suggested by A. W. Morris in United States patent No. 1227174. The inventor claims the presence of iron operates to reduce the shrinkage of the castings or forgings, thus overcoming the danger of cracking. The iron, it is claimed, also increases the density of the castings and the tensile strength and elongation. The iron can be added to any alloy of aluminum, but its aluminum content should not be under 70 per cent.

The percentage of iron should not be less than 1 per cent, or more than 6 per cent, and the silicon content of the alloy should be kept low.

A combination of aluminum and beryllium has also been patented by H. S. Cooper, United States patent No. 1254987. It is claimed the alloy produced by melting together the two metals is greatly superior to aluminum alone, and also of lower specific gravity.

Note—This sheet may cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

THE FOUNDRY DATA SHEET, JULY 1, 1920

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

coremaking and drying department and the cupolas.

The center bay is spanned by a 10-ton electric traveling crane made by the Whiting Foundry Equipment Co., Harvey, Ill. Additional hoisting equipment is provided by three column jib cranes supplied by the same company; each one equipped with a Yale & Towne 1-ton chain block. Two of these cranes are situated opposite each other so that one crane swings past the end of one casting pit and the second crane swings past the other. These cranes are employed in many ways but their principal purpose is for handling auxiliary ladles of iron when pouring long castings or castings which are too heavy to pour with one ladle.

The casting pits are concrete and each is 4 x 8 x 15 feet. Five steel rings equally spaced are anchored in the bottom along each side. They are used for attaching the ends of the long bolts employed for binding the molds together before they are poured. The type of flask used on this class of work is clearly shown in Fig. 3. The sides are rolled channel steel sections as shown in Fig. 2 and heavy wooden planks as in Fig. 4. The end plates in both cases are heavy ribbed cast iron and combine the functions of end plate and clamp. The style of handles used for handling the flasks is clearly indicated in Figs. 2 and 3, and the method of affixing the guides for locating the cope is shown in Fig. 3.

Molding Methods

The mold shown in the illustration, Fig. 3, approximately 13 feet long, is for the body of a multiple double-end horizontal drill. The steel drag is not deep enough so a heavy plank frame is built and attached as an upset. A number of bolts are employed to hold the wooden drag together at the ends and in addition several bolts extend from side to side at various points between the ends. On account of the shape of the casting it is manifestly impossible to run any bolts through the sides where they are needed most and therefore it is customary to drive blocks and wedges between the sides of the drag and the wall of the pit to prevent the flask and mold from straining under the pressure of the molten metal.

The pattern for this and similar jobs is split longitudinally down the center. One half is placed on a flat board, a drag set on, filled with sand, rammed and rolled over, after which the drag is lowered into the pit. Under ordinary circumstances the joint of the pattern is kept flush with the joint of the flask but sometimes as in the present instance, on account of the cope not being deep enough to accommodate the cope half of the pattern it was necessary to keep the parting line of the pattern about 6 inches below the joint of the drag. The deep lifts at each end are taken care of by casting light open sand plates corresponding to the shape of the parting at the end of the pattern. These plates are provided with two screw bolts long enough to reach beyond the top surface of the cope. These plates are set on the parting before the cope is lowered into place. Sand afterward is rammed over them in the usual way with the exception that no gaggers or soldiers are needed. When the cope has been rammed to the top, the bolts on these plates are tightened with nuts and washers and are a positive assurance that the pockets will lift when the cope does and furthermore that the pockets will not drop.

The copes on these large jobs are not rolled over to enable the molder to finish and repair the face of the mold. Piers composed of short wooden blocks are built up at each of the four corners to a sufficient height to allow the molder to work comfortably underneath. The piers are built to an approximate height and then the cope is lowered until it touches on the highest. It is held there by the crane until the remaining three piers have been built to the same height. Wedges are inserted between the flange of the cope and the top blocks on the piers and then the crane releases the load. Great care is necessary in building these piers and adjusting the cope so that the load is evenly distributed, otherwise it is likely to slip after the crane has been removed, with disastrous consequences to whoever happens to be working underneath. The solid concrete floor is much better adapted for securing a firm foundation for piers built up in this way than the ordinary sand floor with its many and uncertain hard and soft spots.

None of the molds is skin dried but the larger ones are surface nailed extensively and poured from the bottom through gate cores. Delicate projecting bodies of sand frequently are taken care of by fitting dry sand cores into the pattern and ramming them with the rest of the mold. Local sand is used for making the molds. After the pattern is drawn the face of the mold is nailed, tooled and finished and then given a coating of plumbago which is brushed and rubbed on by hand. Some of the castings are quite large, requiring flasks 6 x 15 feet, but the metal section in nearly all cases is quite light, usually not over ¼-inch. Since many of them afterward are machined on the cope side as well as the bottom and both ends it follows that the molding, melting and casting processes must be carried out with a considerable degree of skill.

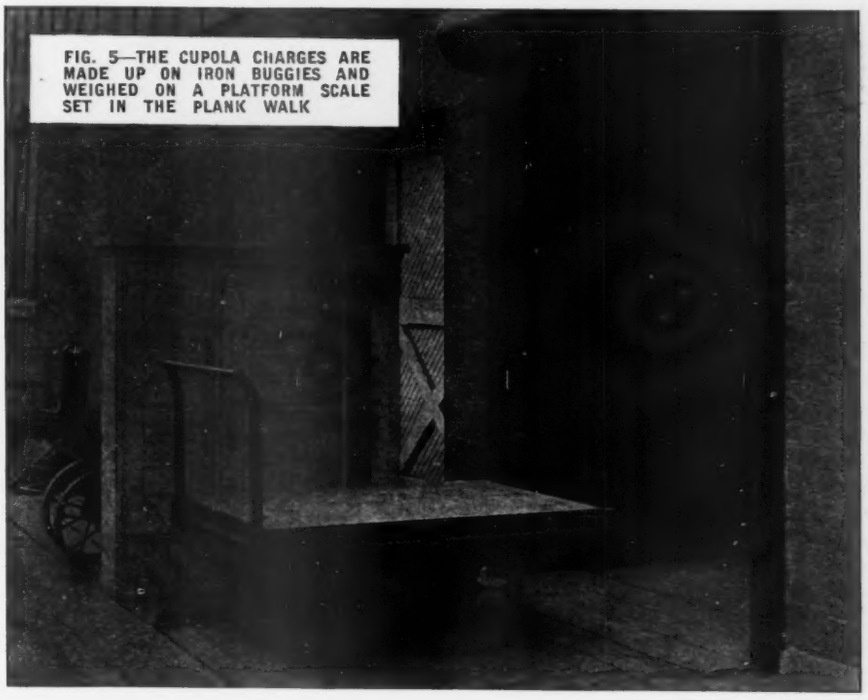


FIG. 5—THE CUPOLA CHARGES ARE MADE UP ON IRON BUGGIES AND WEIGHED ON A PLATFORM SCALE SET IN THE PLANK WALK

A great number of the employes have been with the company for many years. Records of 25 and 30 years are not uncommon. A few men have worked here for 50 years and there is at least one man with a record of 55 years to his credit. The com-

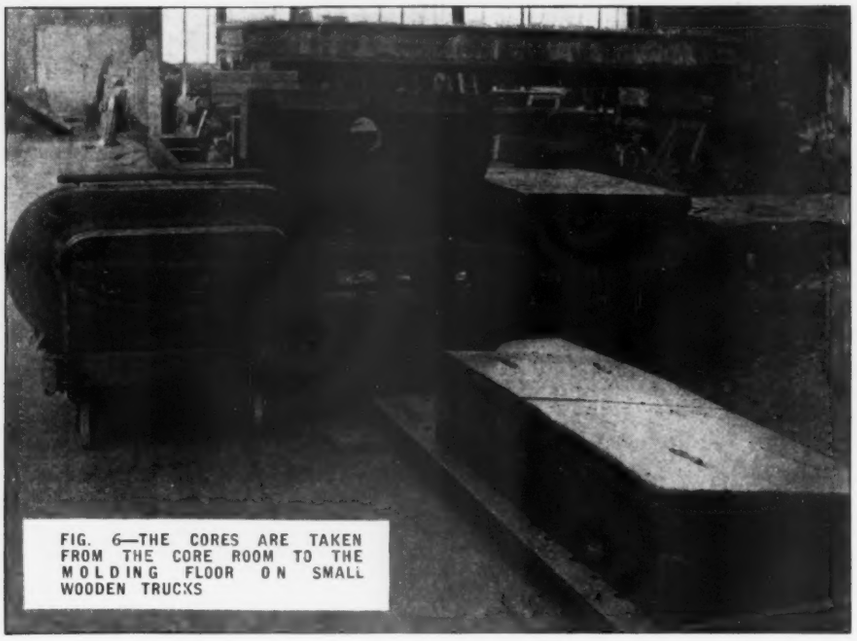


FIG. 6—THE CORES ARE TAKEN FROM THE CORE ROOM TO THE MOLDING FLOOR ON SMALL WOODEN TRUCKS

pany's plant is the main industry of the town, employing as it does nearly 1000 men in the various departments, and it is only natural that the sons of the older men as they grow up enter the office and shops where their fathers have been working, some of them all their lives. This digression is pertinent at this point because the circumstances outlined exert an undoubted influence on the character of the work turned out. It also furnishes an interesting sidelight on the policy and aims of a company. Many of these veterans still are hale and hearty and go through their allotted day's work with as much apparent ease as men many years their junior. However, a few are delegated to keep the shops clean and tidy. For this purpose they are much more satisfactory than younger men. They take their duties seriously and do not have to be either watched or driven. It is true they do not work rapidly, but there are enough of them to cover the ground comfortably and as a result the shop always looks as if it had just gone through a thorough cleaning.

Use Battery Trucks

The heavy castings are taken by the crane directly from where they are poured and set on the floor near one end of the shop. Here they are chipped and cleaned, any necessary grinding being done by pneumatic flexible shaft grinders made by the Chicago Pneumatic Tool Co., Chicago. After they are cleaned, they are loaded on electric lift trucks and hauled into the machine shop. Several of these trucks are employed around the plant, some made by the Cowan Truck Co., Holyoke, Mass., and the others by the Elwell Parker Co., Cleveland. Their use is greatly facilitated by paved and concrete floors in all departments and concrete roads in the yard connecting the different shops.

The small casting molding floor occupies all the space in one of the side bays with the exception of a space 40 x 40 feet at one end which is used for a cleaning room. The molding floor is spanned by a hand controlled, 3-ton, electric traveling crane made by the Whiting Foundry Equipment Co., Harvey, Ill. The cleaning room is enclosed by a hollow-tile wall and is equipped with the usual appliances for cleaning small castings. The mechanical cleaning equipment was supplied by the W. W. Sly Co., Cleveland, and includes two large and two small tumbling barrels. They are provided with wire screen guards in front and also with individual cranes for handling the doors. The entire battery is driven from one shaft which in turn is actuated by a 20-horsepower Westinghouse motor. A dust arrester exhausts all the dust and dirt from the tumbling barrels while they are in motion. Two double grinding wheel stands driven by a 15-horsepower Westinghouse motor were supplied by the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn. They are located in one corner of the cleaning room. The small castings are carried into the cleaning room by wheelbarrows and lift trucks. After tumbling in the barrels for a certain length of time they are taken out and the necessary chipping done on two long benches which parallel each other nearly the full length of the room. These benches are equipped with a number of vises for holding the work. A drawer in the bench in the vicinity of each vise serves for holding the chisels, files and other tools used by the men who work in this room. The castings from the cleaning room also are loaded on lift trucks and transported to the machine shop in the same manner as the large castings previously mentioned.

Flour Used for Binder

In the second side bay are the core-making and drying departments, the cupolas, blower, charging room and elevator, the mold drying ovens which are never used for that purpose, the locker and wash room, the pulley and hanger molding floor, and the brass shop.

Michigan City sharp sand is used exclusively for all the cores. For the smaller shapes and stock cores it is

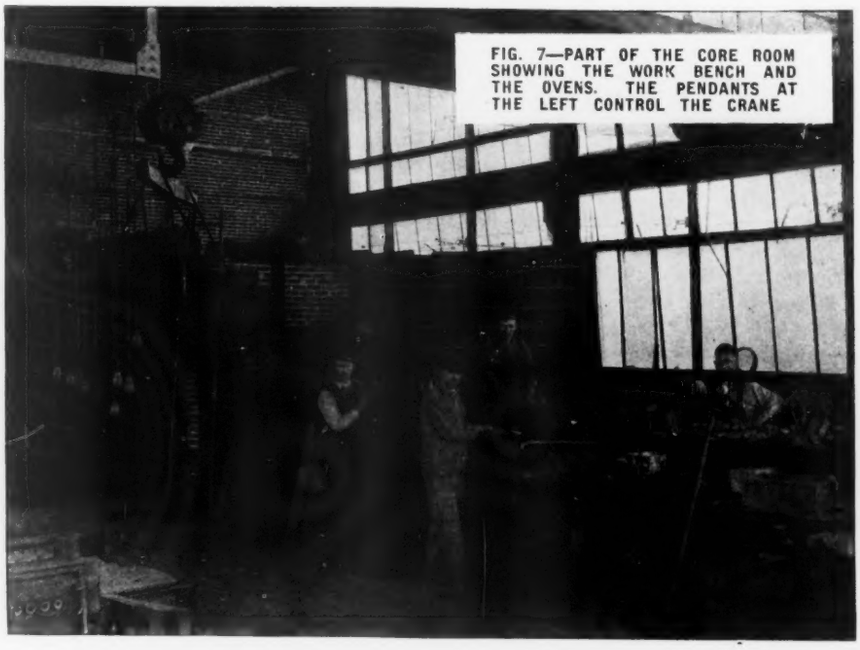


FIG. 7—PART OF THE CORE ROOM SHOWING THE WORK BENCH AND THE OVENS. THE PENDANTS AT THE LEFT CONTROL THE CRANE

used in a practically pure state mixed with an oil binder, while in the larger cores a certain proportion of clay, dug on the company's property, is added in varying amounts of from 10 to 20 per cent, depending on the bulk of the core and other governing factors. Flour is used for a binder in all the large cores. This is not the rich, sticky, glutinous flour used so commonly in the foundries a few years ago, but still flour of a kind. In fact, it is a mooted question if this so-called inferior flour is not superior to the regular article for this particular purpose. It is true a larger quantity is required to bond a given amount of sand but this feature is offset by the fact that it burns out more readily and therefore offers less resistance to the natural contraction of the casting. This is an important factor in the production of long castings having only a light metal thickness. A core which is too stiff through using a strong binder interferes with the contraction sufficiently to throw certain portions of the casting out of their calculated position. In extreme cases this will result in rupture of the casting at one or more points. Rods, bars and pieces of pipe are used exclusively for reinforcing the cores. The custom prevalent in the majority of shops of using cast iron core arbors is not practiced here.

Core Room Well Equipped

The core room is spanned by a 3-ton electric traveling crane made by the Whiting Foundry Equipment Co., Harvey, Ill., and operated from the floor by a number of pendant controls similar to the crane on the side molding floor. The sand for the cores is mixed in a revolving machine supplied by the Arcade Mfg. Co., Freeport, Ill. A similar machine is used for riddling the facing sand used by the molders. These machines are mounted on wheels and may be moved to any convenient location. A number of hand-propelled trucks like these illustrated in Fig. 6 are used for transporting the large cores from the core room to the molding floor.

The two core ovens are situated side by side with a dividing wall between. The fire places are located underneath at one end of a chamber which conducts the heat into the oven through a series of rectangular openings in the floor. Access is had to the firing chamber by a flight of steps leading down from an opening in the passage separating the end of the foundry building from the storage bins and the stockpile. A round opening a short distance from the stairway and provided with a cover when not in use is the medium through which coke is dumped down into the chamber in front of the firing doors. Each oven is 6 x 8 x 10 feet and capable of accommodating two of the 5-deck cars. These cars may be either used singly or coupled together for supporting long cores.

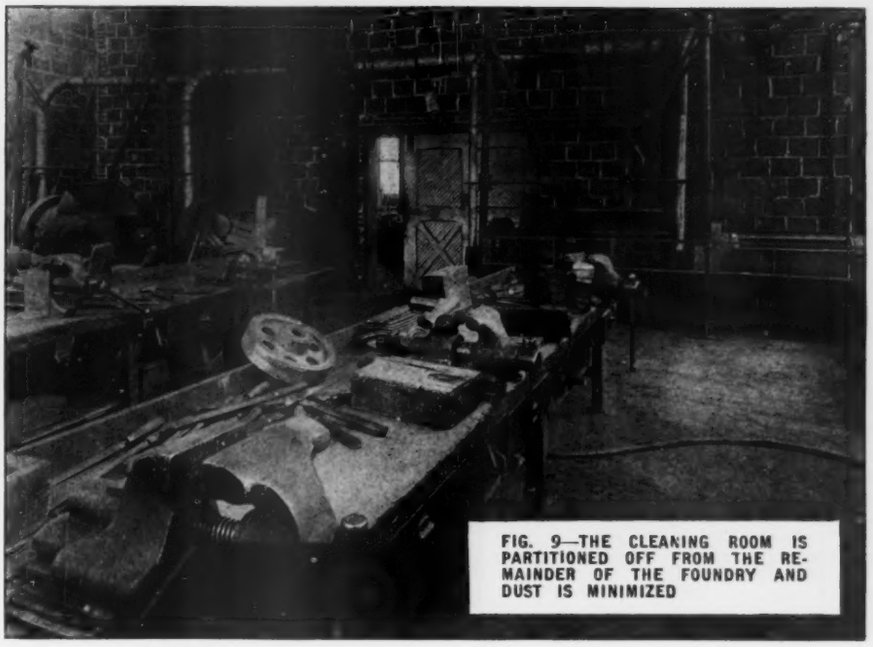


FIG. 9—THE CLEANING ROOM IS PARTITIONED OFF FROM THE REMAINDER OF THE FOUNDRY AND DUST IS MINIMIZED

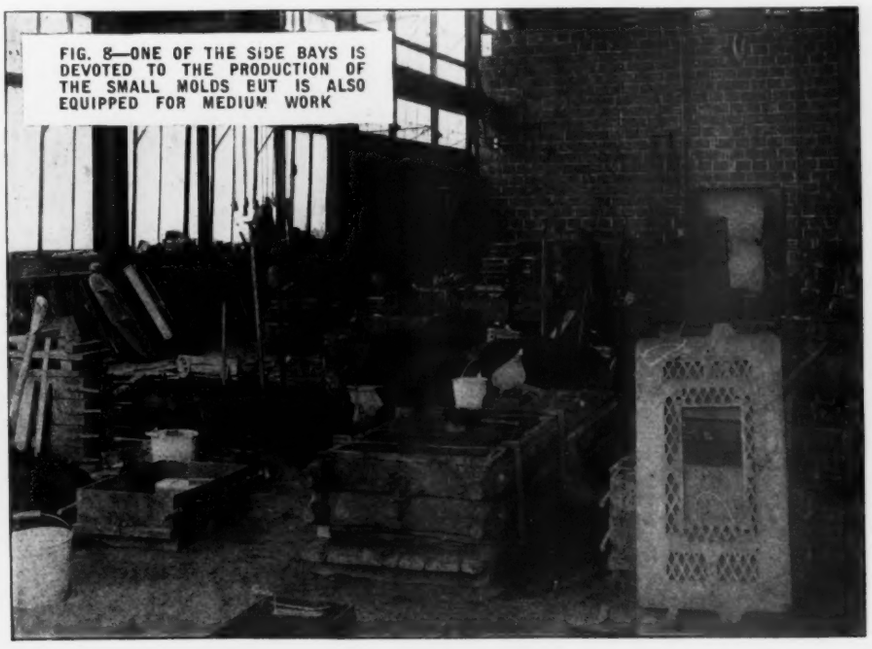


FIG. 8—ONE OF THE SIDE BAYS IS DEVOTED TO THE PRODUCTION OF THE SMALL MOLDS BUT IS ALSO EQUIPPED FOR MEDIUM WORK

Two similar ovens are provided for drying molds in case such a contingency should arise. The fireplace for these ovens is inside the foundry building. A wash, locker and toilet room is situated over these two ovens and is separated from the charging floor of the cupola by a brick wall. Access is had to the room by a stairway situated between one of the ovens and the wall of the cupola room. A space between the ovens and the end of the building is utilized as a molding floor for making small pulleys and shaft hangers. This class of castings is a fairly standard product and is made in considerable quantities on a pneumatic, jolt, pattern draw roll-over machine made by the Tabor Mfg. Co., Philadelphia.

Melting Facilities Modern

The floor back of the ovens, with the exception of the space taken up by the firing pit, is devoted to the manufacture of brass castings. Two pit furnaces of the ordinary coke fire, natural draft type are used for melting the brass.

As may be seen from the illustration, Fig. 1, the cupola room is entirely enclosed by a brick wall the only openings in which are a door in front together with two openings for the

FIG. 10—THE STOCK YARD AND STORAGE BINS ARE SITUATED CLOSE TO THE END OF THE FOUNDRY

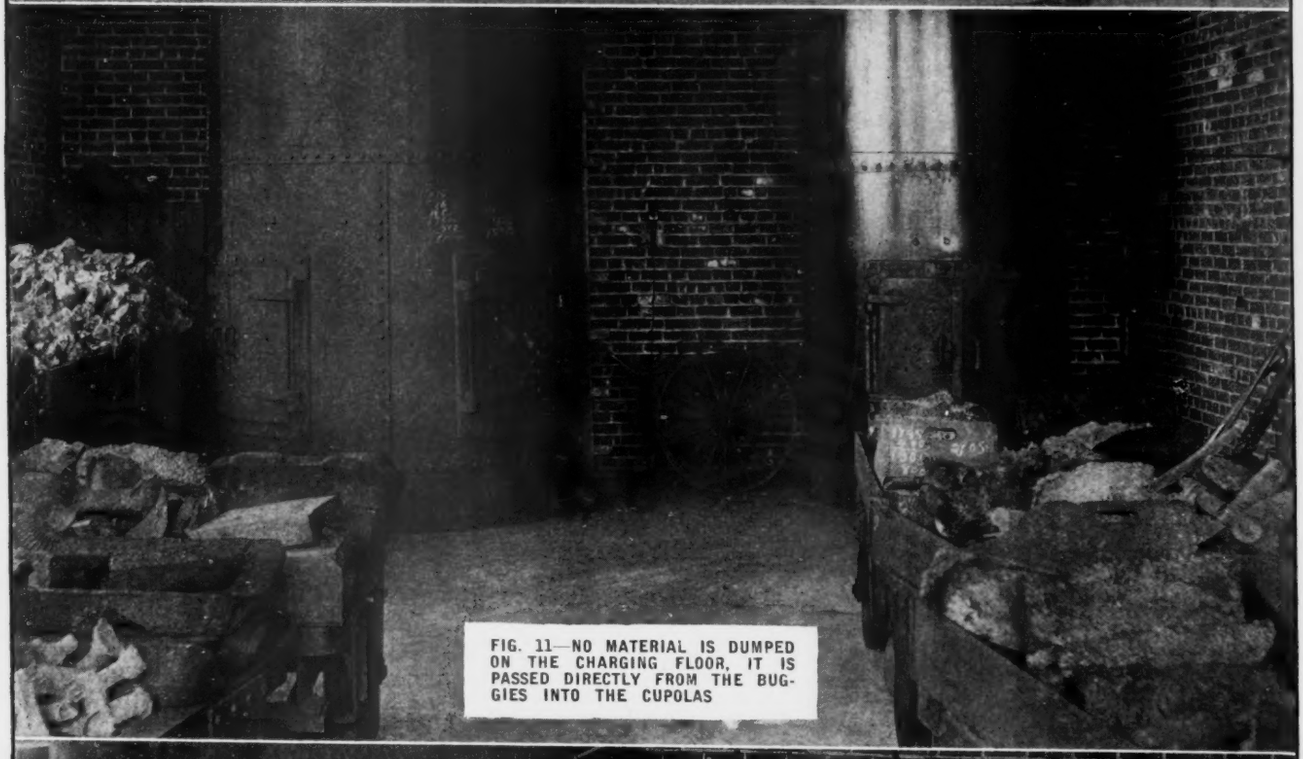


FIG. 11—NO MATERIAL IS DUMPED ON THE CHARGING FLOOR, IT IS PASSED DIRECTLY FROM THE BUGGIES INTO THE CUPOLAS

FIG. 12—THE CORNER BACK OF THE MOLD OVENS IS UTILIZED AS A BRASS SHOP

cupola spouts; and another door at the back communicating with the elevator. Two cupolas supplied by the Whiting Foundry Equipment Co., Harvey, Ill., are used for melting the iron. The volume of work varies considerably so there is no regular sequence in using the cupolas. When the heat is heavy the large one is used and when the heat is light the iron is melted in the small cupola. The large cupola has a shell 72 inches in diameter and the small one 52 inches. Each cupola is double lined up to the charging door. Therefore the large cupola has an inside diameter of 54 inches and the small one 34 inches. The charge for the small cupola consists of 1000 pounds of coke on the bed followed by alternate layers of iron and coke in the ratio of 1 to 8. The composition of the charge varies occasionally on account of the work in hand but a typical charge is made up of pig iron and scrap in the proportion of 1000 pounds of pig iron to 600 pounds of scrap. From one to three brands of pig iron are constantly used in varying proportions depending on the kind of work which has to be poured on any particular day.

A spur from the Wabash railroad runs through the yard and the material is unloaded directly from the cars. The pig iron is piled in neat and orderly rows. The coke is unloaded into a large bin and the sand, facing, lime stone, etc. are unloaded into a row of covered concrete bins separated from the end of the foundry building by the width of a plank walk.

The charge for the cupola is made up on a number of trucks and weighed on a Fairbanks platform scale situated in the plank walk in front of the elevator door. No material is dumped on the charging floor. The iron and coke is transferred direct from the cars to the cupola.

Several buildings are devoted to the storage of the immense stock of patterns which the company has accumulated in the years it has been doing business. As has been stated, the Defiance company does a great deal of special work but it also issues a catalog of over 700 different standard machines. These machines go to all parts of the world and it is nothing uncommon for the company when engaged in preparing a new issue of the catlog and preparing to eliminate some of the machines which have not figured on the order books for years to receive orders for some of the parts. The patterns are so arranged in the pattern storage and card indexed in the office that it is no trouble to find any given pattern at any time. A small building immediately in front of the main foundry door is utilized for storing the *live* patterns, that is the patterns that are actually in use in the foundry. They are placed there a day or two before they are needed in the foundry and are returned after the molders are through with them, pending their removal to the permanent pattern storage.

The molding flasks, both wood and iron, are stored in a building, 60 x 132 feet, separated from one side of the foundry building by a wide concrete gangway. This building is of steel frame construction and is made with one side, two ends and a roof. The side nearest the foundry is open the full length which permits flasks to be placed in the building or removed from any point with a minimum of trouble. A number of monorails supporting Yale & Towne chain blocks span the building from side to side and serve to handle the heavy flasks. The lift trucks are employed for conveying the flasks to and from the foundry.

FIG. 13—THE FLASKS ARE KEPT UNDER COVER IN A SHED EQUIPPED WITH MONORAILS AND CHAIN BLOCKS FOR HANDLING THEM

The American Foundry Equipment Co. having outgrown its sales and executive offices at 52 Vanderbilt avenue, New York, has removed to a large suite in the Marlin-Rockwell building, 366 Madison avenue.

The Henry-Miller Foundry Co. recently changed its name to the Henry Furnace & Foundry Co. This company operates plants at Cleveland, Medina, Chagrin Falls and Canton, O.

How and Why in Brass Founding

By Charles Vickers

Heat Resisting Alloys to Meet Pressure Tests

We are having difficulty in making castings for gasoline burners owing to the fact that they will not withstand the pressure of 50 pounds of compressed gasoline with which they are tested. The burner works at a white heat, and we lose from 25 to 33 per cent of the castings we make. We have many different methods of molding but have the best results with upright pouring, and heavy shrink balls as feeders. We have used both oil-fired and coke-fired furnaces in melting. The coke-fired gave the best results. We pour the metal hot and an alloy of copper 90 per cent, tin 10 per cent, gives the best results. We have tried the following alloys: (1) *Copper, 70 per cent; tin, 5 per cent; lead, 2.50 per cent, and zinc, 1.50 per cent.* (2) *Copper, 84 per cent; tin, 14 per cent; zinc, 2 per cent.*

The cores are made with rosin binder; we have tried other mixtures, but rosin appears to be the best. We would be grateful for any suggestions you may be able to offer.

The following alloy is frequently used for gasoline burners: Copper, 78.75 per cent; zinc, 15 per cent; lead, 3 per cent; tin, 3 per cent, and phosphor copper, 0.25 per cent. A stronger alloy having a good reputation for withstanding pressures follows: Copper, 82 per cent; tin, 7.50 per cent; lead, 5.50 per cent, and zinc, 5 per cent. None of the above alloys will work at a red heat, however, as the metal will soften and crumble. For a red heat it will be necessary to use an aluminum bronze containing iron, but this alloy is difficult to cast so that it will withstand pressures. Nickel alloys work well at high temperatures, but also are difficult to cast. The following alloy is worth trying: Copper, 88 per cent; tin, 9 per cent; nickel, 1 per cent, and zinc, 2 per cent. Alloys of copper with less than 8 per cent tin are not good for high temperatures. A low brass, such as copper, 90, and zinc, 10 per cent, withstands heat better than the bronzes, while an alloy of copper with 5 per cent nickel is better than the zinc alloys. It may be possible that the design of the casting is faulty. If leaking persists at certain places, it would be advisable to smooth wax onto the pattern at the leaky points, thus thickening the walls, or rounding out the corners, then test a few heats of the improved patterns. As the molding, melting and coremaking part of the process of making these castings appears good, we are inclined to think the fault lies in the design of the castings and would suggest that all corners be well filleted and the parts most susceptible to leakage be increased in thickness.

Mention is made of the castings being worked at a white heat; at such a temperature the metal would melt and run like water, consequently we will assume that it is meant the flame appears at a white heat; the metal itself cannot be red hot, otherwise no copper alloy is suitable for the service. It will do no harm to add 2 per cent nickel to the copper, 90 per cent, tin, 10 per cent alloy, as it will have the effect of closing the grain of the metal.

Molding Sand Mixtures for Aluminum

We are contemplating engaging in the manufacture of aluminum castings for vacuum sweepers, making around 200 per day, and would like to learn all it is possible to know about this subject, with especial reference to molding and core sands, binders and mixtures of metals.

Molding sand of suitable quality can be supplied by any of the regular supply houses. It must be open in texture and not too coarse in grain. Cores for vacuum cleaner castings must be soft and friable, otherwise the castings will crack in cooling. What is known as the mixture for shell cores will be satisfactory. This is made as follows: Old molding sand from the floor, 8 shovelsfull; silica sand, 3½ shovels; new molding sand, 4 shovels; fine sawdust, 1 shovel. Riddle this mixture through a ¼-inch riddle after mixing the same thoroughly. The binder consists of 1 quart molasses previously mixed with the sawdust. The mixture must be thoroughly mixed, by milling and sieving.

The most suitable alloy to use consists of copper 8 per cent, aluminum 92 per cent. An oil or gas-fired furnace fitted with an iron melting pot is satisfactory for melting aluminum for the class of castings it is desired to make.

Alloys Recommended for Bearing Metal

We are experiencing difficulty with a highly leaded alloy. The lead appears to separate leaving spots on the finished surfaces of the casting. The metal is bought ready mixed in ingot form, and has the following composition: Copper, 72 per cent; zinc, 9 per cent, and lead, 19 per cent.

The difficulty is due to the alloy which is not a practical mixture. The remedy is to change the formula and obtain a mixture that can be cast in sand and produce castings free from the difficulty outlined. It is presumed that the mixture is used for bearing purposes, otherwise, it would not contain such a large amount of lead as you have mentioned.

The following mixture is better and will quickly save its increased cost because the castings will be good, instead of scrap. To make the mixture take 55½ pounds of alloy containing copper, 72 per cent; zinc, 9 per cent, and lead, 19 per cent, and weigh 30 pounds of copper, either scrap or ingot, place the copper in the bottom of the crucible, if the latter is used, or in the bottom of the furnace, if of the non-crucible kind, then place the 55½ pounds of alloy on top of the copper and melt, using a cover of charcoal. When the mixture is molten, add 9½ pounds lead and 5 pounds tin. This will produce an alloy of the following composition: Copper, 70 per cent; tin, 5 per cent; lead, 20 per cent, and zinc, 5 per cent. This is a very satisfactory bearing mixture. It can be used for any purpose the ingot metal was intended for and will give much better results.

Brass for Name Plates

We have a number of name plates to make and would feel favored to receive suitable mixtures, for both red metal and yellow brass castings which may answer for this purpose.

A good red metal for name plates is the following: Copper, 90 per cent; tin, 6 per cent; zinc, 2.50 per cent, and lead, 1.50 per cent. For a yellow mixture use, copper, 70 per cent; zinc, 25 per cent; lead, 3 per cent, and tin, 2 per cent.

Electrical Melting of Alloys---IX

Rapid Strides Made in the Development of Electric Brass Furnaces Have Introduced Changes in the Past Few Months—Statistical Study Presented

H. W. GILLETT

FORMER articles of this series have described the more prominent types of electric furnaces for melting brass. It remains, before discussing questions of choosing a particular furnace for a particular job, of installation and of operation, to deal briefly with a few other furnaces and with some of the newer developments on those already described. The moves in developing electric brass melting are made so rapidly now-a-days that it is difficult to keep up with them all. An example of the trend in industry is furnished by two firms which formerly specialized in buying borings and similar scrap, briquetting them and selling the briquets. These companies have had their business diminished in consequence of their former customers having found it cheaper to handle their own scrap by electric melting, and both are planning to install electric furnaces and sell ingot metals.

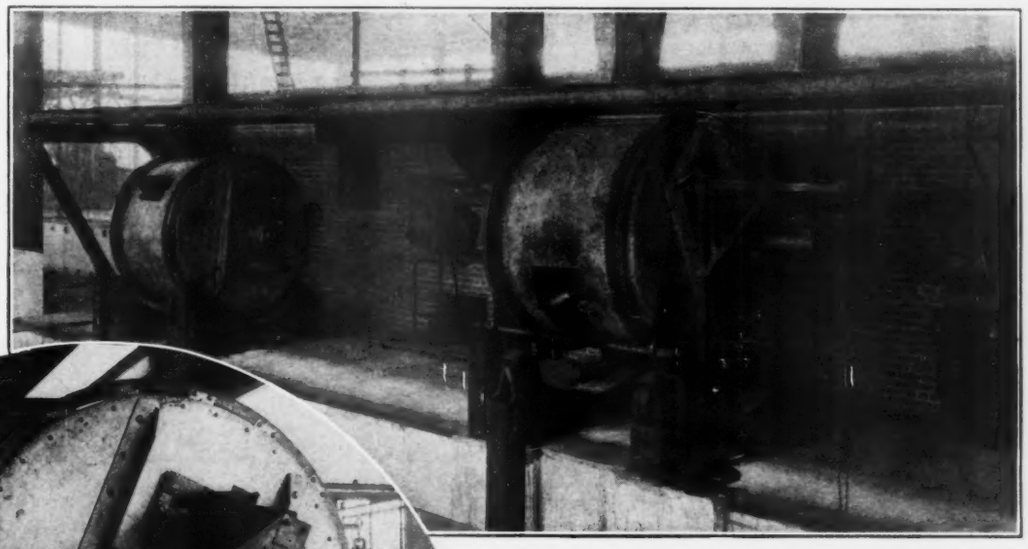


FIG. 1—INSTALLATION OF DETROIT ROCKING FURNACE —IN POURING POSITION

FIG. 2—DETROIT ROCKING FURNACES EQUIPPED FOR DIRECT POURING—FURNACE AT THE LEFT IN ROCKING POSITION, AT THE RIGHT, IN POURING POSITION

As to individual advances, taking these up in the order in which the furnaces have been dealt with in this series of articles, it may be noted that the Ajax-Northrup furnace, which has been taken over by the Ajax Electrothermic Corp., Trenton, N. J., has been developed so that high-frequency furnaces of 100 kilowatts now are considered commercially feasible. A new high-frequency generator of simple design has been tried with gratifying results. Even with the condensers and oscillatory current that must be relied upon until the high frequency alternator is ready for use, rapid progress has been made, a 3-phase system having been developed by which the capacity of each condenser has been largely increased and hence the cost of the outfit per kilowatt decreased. A 60-kilowatt nose-tilting furnace of 500 pounds capacity just built for melting silver, shows a power factor of about 70 and is expected to melt sterling silver at 250 kilowatt hours per ton, since much smaller furnaces at the Philadelphia mint have been handling coinage silver at the rate of 270 kilowatt hours per ton. The previously feared danger to life from the high voltage, high frequency current seems to be groundless, as recent tests indicate that the current used is not dangerous. Prospects look bright for the production of high-frequency current melting outfits at a cost no greater than that of other types of similar sizes, and, in the smaller sizes, say 20 to 30 kilowatts, probably at a lower cost. That is, there is hope of ultimately extending electric furnace operation to the small shop with low production, since the Ajax-Northrup type is more suited to intermittent operation than other types. The General Electric Co., Schenectady, N. Y., also is paying attention to the small shop, and is developing a 30 kilowatt crucible lift-out, single phase furnace. This is planned for such work as that of metallurgical laboratories of manufacturing jewelers, and of such shops as have to melt small quantities of nonferrous metals in rooms where the use of a fuel-fired furnace is inadmissable. The crucible takes 25 pounds and the furnace is planned to make two heats an hour after it is hot. The heat is generated in a similar manner to that in the General Electric hearth furnace, being radiated and reflected to the crucible instead of to

a hearth. The power consumption is high, being calculated at the rate of 1200 kilowatt hours per ton with the furnace hot. The furnace naturally is not one of much interest to a plant with any appreciable output of nonferrous metals, but may be of interest where cleanliness and convenience are paramount in the melting of small quantities of metal.

A recent development in the rocking arc type furnace, that of a form adapted to direct pouring, was mentioned in a previous article, but details were not then available. Figs. 1 and 2 show direct pouring Detroit Rocking furnaces in process of erection. In this form the furnace while melting rests on an improved base, which now is also used in the ladle-poured forms, having superseded the form shown in the photographs on page 403 of the May 15 issue. When pouring, the furnace is rocked forward till the bar in front engages the sockets in the front of the base and a lifting screw at the rear is swung into position so that it engages the rear hinge. The motor-actuated screw then rises, lifting the furnace bodily off the gears and rollers, so that the furnace is supported and tilted like all nose-tilting or direct-pouring furnaces. The bar is located below the lowest position of the spout during rocking and hence does not interfere with the motion. Figs. 1 and 2 also show an overhead charging platform.

Some recent data on rocking furnace performance in the 1-ton size, showed less than 210 kilowatt hours per ton on 24-hour operation with clean charges of 60-40 brass in rolling mill work, on a 50-ton run, made at a rate to give an average output for the furnace of 18½ tons per day.

Another 1-ton furnace is claimed by the users to give 6 tons per day at about 280 kilowatt hours per ton in 10-hour operation on melting cabbaged wire and scrap copper into wire bar, and to produce metal of 100 per cent conductivity, Mattheisen scale, without the use of fluxes or deoxiders. These results, both as to power consumption and quality of product require expert operation.

Of the furnaces not yet described, one is an indirect arc furnace in which the furnace is kept in motion while operating thus falling into the same general class as the Detroit, the American, and the Booth furnaces. This the Moore Rapid 'Lectromelt furnace, sold by the Pittsburgh Furnace Electric Corp., Pittsburgh. Although the furnace has been advertised for some months, no detailed description has been given out, even to prospective users, and no commercial installations have been made, though one experimental furnace is said to have been constructed. The only approach to a description is the following, taken from advertisements of the furnace.*

"Heat is transmitted to the charge by distributed radiation and reflection only. Arcs are struck between the electrodes rather than against the charge. Segregation and volatilization are minimized. They use polyphase or single-phase power."

Another rocking indirect arc furnace recently has been described by Reardon,** which is said to have been thought of in December, 1913, but on which it is stated that no figures were available in May, 1920. The idea is to insert electrodes in place of the oil burners in a Schwartz furnace. The bureau of mines converted a 100-pound Schwartz furnace into an electric unit in this way in March, 1913, and did not rock it while running.

Reardon's present idea is to rock the furnace, but on account of the location of the charging door and pouring spout, only about half the lining can be washed by the metal, which will tend to give a short lining life in the unwashed portion. Reardon specifies 300 kilowatts, for a 1-ton furnace, the normal power input for electric brass furnaces of that capacity, but plans to use 220 volts, which the writer believes would give too long an arc for good results. This makes the fifth modification of the moving indirect arc furnace to be designed for brass melting.

While the possibility of utilizing old Schwartz furnace shells is interesting, the writer believes it to be cheaper in the end to use an electric furnace designed as an electric furnace rather than a made-over oil furnace.

TABLE I

Electric Furnaces for Nonferrous Melting

Direct Arc Furnaces

Make	No.	User	Alloy	Capacity tons per heat per furnace	K.W. rating per furnace	Total K.W.	Remarks
Heroult	2	Driver-Harris Co., Harrison, N. J.	nickel alloys	2	800	1600	Automatic electrode control
Greaves-Etchell	1	Hoskins Mfg. Co., Detroit	nickel alloys	½	300±	300	Automatic electrode control
Snyder	1	Monel Metal Products Co., Harrison, N. J.	Monel	½	100	100	
Snyder	1	Monel Metal Products Co., Harrison, N. J.	Monel	2	400±	400	
Snyder	1	Chrobaltic Tool Company, Chicago, Ill.	cobalt chromium	⅛	60	60	
Snyder	3	Haynes Stellite Co., Kokomo, Ind.	cobalt chromium	⅛	60	240	
Snyder	2	Chicago Bearing Metal Co., Chicago, Ill.	bearing bronze	1	400	800	Automatic electrode control.
Total	11					3500	

Harvey Modified Indirect Arc

A sixth modification has recently been patented by an English designer,* in which a furnace proportioned something like a pint milk bottle with a rounded bottom, has its neck closed by a door carrying either a solid resistor, or electrodes between which an indirect arc is struck. The furnace chamber is tilted off the vertical, and then rotated or rocked, the idea being to wash as much of the walls with the metal as possible.

The use of a solid resistor so supported seems impractical to the writer, and arc electrodes so inserted would be in a cramped position, both as regards adjustment from the outside and the location of the arc inside.

Another furnace which has not been described in detail is not yet on the market. This unit, which is in full commercial operation on alloys ranging from yellow brass to pure copper, is the Bennett, which was developed at and for the Scovill Mfg. Co., Waterbury, Conn., after long and thorough experimental work on many other types of furnaces. Instead of being heralded with a flourish of trumpets before any furnaces were in commercial operation, this has been a *mystery* furnace. The men who designed and developed the furnace have been unable to discuss it freely or to give out any data whatever on its performance, on account of the

*Metal Ind., Vol. 18, Feb., 1920, Advt. p. 10. Elec. World, Vol. 75, April 24, 1920, Advt. p. 98.

**Reardon, W. J., Electric Melting in an Oil Furnace, Metal Industry, Vol. 18, 1920, p. 207.

*Harvey, L. C., U. S. Pat. 1337839, April 20, 1920.

company's very strict policy of secrecy.

It has not yet been decided whether the furnace will be made available to other users, or kept solely for the Scovill Mfg. Co. In the former case, prospective users naturally will demand data by which it may be compared with the furnaces on the market, but unless and until that situation arises, the furnace probably will remain behind a dark veil of secrecy, instead of in the spotlight.

The only published information is that found in a recent patent,* and this, according to its inventor "does not cover all the points, as many important features are still in the patent office, and patent applications on more features are still to be made." The patent is for a process, rather than a furnace, and obviously is not worded to impart any more information than can be helped.

However, the installation demands consideration, because it is in commercial operation in a rolling mill of high standing. There are six 1-ton and one 5-ton Bennett furnaces in operation at the Scovill plant, the latter being the largest electric brass furnace yet built. Moreover, the principle used is a vastly interesting one from the point of view of theory.

Briefly, the furnace closely resembles an ordinary 3-phase Heroult, direct-arc, steel furnace, which uses 50 to 75 volts between each electrode and the charge, which, as has been shown before, will not operate on alloys high in zinc without excessive metal loss. The main point of difference is that the Bennett furnace is not run as an arc furnace but as a *contact resistance* furnace. There usually is supposed to be a minimum voltage below which a true arc cannot be struck, or held. Nevertheless, if a voltage below this minimum be impressed on a circuit in which there is a poor contact, current will flow and resistance heating will be set up at the poor contact. It is possible in melting yellow brass, that a little zinc vapor might be evolved at the poor contact and that current would then flow along the vapor. This, however, would hardly explain the action of the furnace when melting copper. According to the patent, the voltage between any one electrode and the charge should be from 18 to 20 on the 1-ton size, while on the 5-ton size, 32 to 40 volts may be used.

This is quite analogous to electric furnace practice used abroad for melting ferromanganese for making additions to steel. Manganese is fairly volatile, and somewhat the same problem arises as on alloys containing zinc. Rodenhauser* discusses the question in considerable detail. He shows that the various ferromanganese melting furnaces used are run at far lower voltages than in melting steel. On ferromanganese the Heroult and Girod furnaces are run at around 45 volts and require a thick slag to prevent volatilization, the Keller, at around 30 volts, requiring a thinner slag, and the Schemmann and Bronn, at around 20 volts with only a trace of slag.

Bennett emphasizes the necessity for keeping the voltage low, and for keeping the rate of power input down, so that the heat may be distributed through the charge and not pile up near the electrode, both in order to avoid too great local overheating.**

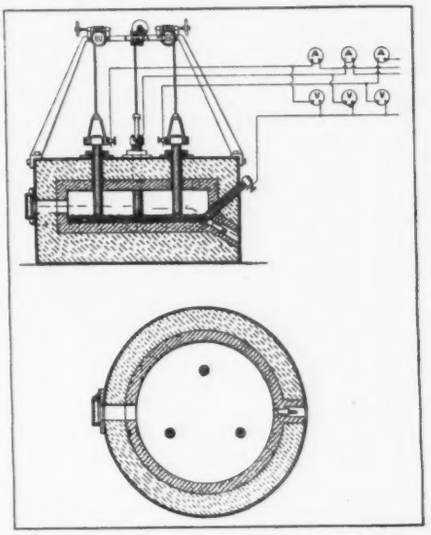


FIG. 3—PATENT OFFICE DRAWINGS ILLUSTRATING ANNOUNCED FEATURES OF THE BENNETT FURNACE

He also stipulates that the arrangement of the electrodes should be such as to set up an electromagnetic field in the metal and produce slight circulation of the metal in order to get what stirring is possible, to avoid local overheating. This is similar to the Heroult furnace.

Circulation Not Sufficient

As Hess*** points out, however, the circulation in the Heroult furnace is not sufficient to give proper mixing of steel without further stirring.

According to the patent, the Bennett furnace takes 2500 amperes per electrode in the 1-ton size and 4200 in the 5-ton. With the voltages given between electrode and charge and with the probable power factor, these figures, in a 3-phase furnace, calculate to a power input of around 150 kilowatts in the 1-ton and 500 kilowatts in the 5-ton size. This is a lower rate of power input than is used in such furnaces as the rocking type or the General Electric and is almost as low as in the Baily. The ratio of heat usefully applied to that lost by radiation will therefore be low and the efficiency therefore not high. This condition is helped considerably by the fact that the heat is generated close to the charge. The furnace should have an efficiency above the Baily, and General Electric furnaces; of the same order as the Rennerfelt reverberatory, and direct arc and stationary indirect arc furnaces, and below that of the rocking arc or the induction types. The metal losses are said to be low. The refractory life cannot be estimated.

The furnace must be successful, or the Scovill Mfg. Co. would not use it, and if it is ever put on the market, there will be still another electric brass furnace added to the different types the brass melter has to choose from.

The furnace, as shown in the patent drawings, is illustrated in Fig. 4. The figure is highly diagrammatic. The writer doubts if the furnace has a flat roof, if the charging door is as small as is shown, or if the electrodes are hand-regulated from up in the air as shown. The object that looks like an electrode at the right does not carry power, but merely serves to show the voltage between the three electrodes and the bath, so that the proper voltage may be maintained, which is undoubtedly done automatically in the actual furnace.

So much for the electric brass furnaces in commercial use and being developed for that end. It has been shown that electric melting is commercial for nickel alloys, silver, copper, brass and bronze. Only one important class of nonferrous alloys remains for which electric melting need be considered—the light aluminum alloys.

Data on electric melting of aluminum is about as scarce as that on electric brass melting was three or four years ago, and it is necessary to consider it more from the point of view of theory than from present practice. According to data recently gathered by the bureau of mines* about 45,000 tons of light aluminum alloys are produced in the United States every year, around 98 per cent of this being aluminum-copper alloys and only 1 2-3 per cent or 750 tons being aluminum-zinc, or aluminum-copper-zinc alloys. A single electric furnace, of around 1-ton capac-

*Bennett, M. H., U. S. Patent, 1337305, April 20, 1920.

*Rodenhauser, W., Ferromangan als Desoxydation Mittel—1915, p. 26. See also Schemmann, W., and Bronn, J., U. S. Pat. 1056456.

**Compare the author's comments, The Foundry, Vol. 48, 1920, April 15, pp. 319, 320, and the use of the DeNolly Grammont ferro-manganese melting furnace on brass, p. 320.

***Hess, H. L., Electric furnaces as applied to steel-making, Mech. Eng., Vol. 41, 1919, p. 245; Chem. Abstr., Vol. 14, 1920, p. 16.

*Anderson, R. J., Casting Losses in Aluminum Foundry Practice, bulletin U. S. bureau of mines (soon to be published).

TABLE II

Furnaces for Nonferrous Melting

Moving Indirect Arc Furnaces

Make	No.	User	Alloy	Capacity tons per heat per furnace	K.W. rating per furnace	Total K.W.	Remarks
Detroit rocking	2	Aluminum Mfgs. Inc., Detroit	brass and bronze	1	300	600	
Detroit rocking	2	American Bushing Corp., Marysville, Mich.	brass and bronze	1	300	600	
Detroit rocking	2	American Manganese Bronze Co., Holmesburg, Pa.	brass and bronze	1	300	600	
Detroit rocking	5	C. B. Bohn Foundry Co., Detroit	4 on brass and bronze—1 on Al	1	300	1500	
Detroit rocking	2	Bound Brook Oilless Bearing Co., Bound Brook, N. J.	bronze	½	150	300	
Detroit rocking	1	Bridgeport Brass Co., Bridgeport, Conn.	bronze and copper	1	300	300	
Detroit rocking	4	Chase Metal Works Co., Waterbury, Ct.	brass	1	300	1200	
Detroit rocking	1	Cleveland Brass and Copper Rolling Mills, Cleveland, O.	brass	1	300	300	
Detroit rocking	4	Detroit Copper and Brass Rolling Mills, Detroit	brass	1	300	1200	3 nose-tilting furnaces
Detroit rocking	1	Ford Motor Co., Detroit	brass and bronze	1	300	300	
Detroit rocking	1	Ford and Son, Dearborn, Mich.	brass and bronze	1	300	300	
Detroit rocking	2	General Aluminum and Brass Mfg. Co., Detroit	brass and bronze	1	300	600	
Detroit rocking	1	General American Tank Car Corp., E. Chicago, Ill.	brass and bronze	½	150	150	
Detroit rocking	1	Hills, McCanna Co., Chicago, Ill.	brass and bronze	¼	75	75	
Detroit rocking	1	Lumen Bearing Co., Buffalo, N. Y.	brass and bronze	½	150	150	
Detroit rocking	2	Michigan Lubricator Co., Detroit	brass and bronze	1	300	600	
Detroit rocking	4	Michigan Smelting and Refining Co., Detroit, Mich.	brass and bronze	1	300	1200	
Detroit rocking	2	Mueller Metals Co., Port Huron, Mich.	brass	1	300	600	
Detroit rocking	1	Oregon Brass Works, Portland, Oregon	brass and bronze	1	300	300	
Detroit rocking	1	Oregon Brass Works, Portland, Oregon	brass and bronze	½	150	150	
Detroit rocking	3*	Parish-Pool Co., Cleveland, O.	brass and bronze	1	300	900	2 nose-tilting furnaces
Detroit rocking	1	Rome Wire Co., Rome, N. Y.	copper	1	300	300	
Detroit rocking	3	Sherwood Brass Works, Detroit	brass and bronze	1	300	900	
	50**					13,800	

* One of these was formerly used at the Denny-Rine Co., which went out of business.
** 43-300 K.W.; 5-150 K.W., 2-75 K.W.

Among the users of Booth* furnaces are the following

Leitelt Bros., Chicago	⅛ ton
Dearborn Brass Co., Cedar Rapids, Iowa	⅛ ton
Muskegon Aluminum Foundry Co., Muskegon, Mich.	⅛ ton
National Bronze and Aluminum Foundry, Cleveland	¼ ton
Cleveland Brass Mfg. Co., Cleveland	¼ ton
Fulton-Haywood Brass Works, South Bend, Ind.	¼ ton
Dallas City Foundry Co., Dallas City, Ill.	¼ ton

* The 7 furnaces above have been in operation for some time, a total of 20 furnaces had been shipped June 1, and some of the others have been put in operation. The names of the other purchasers have not yet been given out.
This makes the Booth entry in the summary of totals read

Make	No.	Capacity tons per heat per furnace	K.W. rating per furnace	Total K.W.
Booth	8	⅛	75	600
	20	¼	125	2500
	4	½	180	720
	3	1	300	900
Totals	35			4720

Make	No.	User	Capacity	Total K.W.
American	1	York Hardware & Brass Co., York, Pa.	½ ton	306

ity, could melt all the zinc-containing aluminum alloys produced in the country and not have to work much over 10 hours a day to do it.

Since it is only the zinc-containing aluminum alloys in which there is any noteworthy volatilization loss, it is plain that the situation in aluminum is diametrically opposed to that in brass. Oxidation losses do occur, and considerable good metal is entangled in, and skimmed off with the dross, but the net loss of metal in melting the standard No. 12 alloy is probably only somewhere between 1 and 2 per cent. Moreover, those who have had the most experience in electric melting of aluminum doubt that, with the same charge to start, an electric furnace will save enough metal over a well-operated fuel-fired furnace to make much difference on the cost sheets.

The bulk of the aluminum is melted either in iron pots or some type of reverberatory furnace. Where it is still melted in graphite crucibles the pots have a relatively long life.

Hence two of the outstanding advantages of electric brass melting, reduction of metal losses and avoidance of high crucible costs, do not obtain in any marked degree in electric aluminum melting. Therefore, on aluminum, electric melting must justify itself on the score of quality, ease of control, decreased labor cost, or lower cost of electric power than of fuel required.

Quality Is Good

As to quality, every one who has tried electric melting seems to agree that electrically melted aluminum is of good quality, and some seem to feel that it is, or may be, superior. Perhaps because of the good general reputation of the electric furnace on the score of quality in handling of other alloys, some aluminum founders are hoping that the electric furnace may do away with cracks, draws, and porous castings, or may at least eliminate the possibility of these troubles originating in the melting of the metal, thus leaving only the thousand and one molding and core causes that may produce these evils.

Some work has been done on testing the product for porosity in a scientific manner which indicates that the electric furnace offers possibilities, but even these tests often were discordant and contradictory. It can be said with considerable confidence that a reducing atmosphere is better for finishing steel and melting brass than an oxidizing atmosphere. However, in view of the oxidizing atmosphere over an iron pot furnace for aluminum, and the fact that such furnaces can produce good

TABLE II—(continued)

Electric Furnaces for Nonferrous Melting

Stationary Indirect Arc Furnaces

Make	No.	User	Alloy	Capacity tons per heat per furnace	K.W. rating per furnace	Total K.W.	Remarks
Renner-felt	1	Gerline Brass Foundry Company, Kalamazoo, Mich.	brass, bronze and monel	½	100	100	
Renner-felt	2	Chicago Bearing Metal Co., Chicago, Ill.	bearing bronze	1	300	600	
Renner-felt	1	U. S. Mint, Philadelphia, Pa.	bronze and silver	½	150	150	Automatic con-trol, nose-tilting
Renner-felt	1	U. S. Mint, Philadelphia, Pa.	bronze and silver	1	300	300	Automatic con-trol, nose-tilting
Renner-felt	1	U. S. Mint, San Francisco, Cal.	bronze and silver	½	125	125	Automatic con-trol, nose-tilting
Renner-felt	1	Bausch Machine Tool Co., Springfield, Mass.	hardeners for aluminum	⅛	100	100	
Total	7					1375	

and the speed of the centrifugal device must each be just right. The control over the metal made possible by the furnace, and the fact that the furnace itself is automatically operated is considered to make good results more certain and easy than would be possible with a fuel-fired furnace. This furnace has been in use over a year and a half without relining, the only difficulty being that the accretion of oxide in the hearth has cut down the hearth capacity. On account of the low pouring temperature of aluminum compared to brass or bronze, almost any type of electric brass furnace applied to aluminum should have little difficulty in maintaining the refractories.

The General Electric Co. also uses a larger furnace of the same type of about 800 pounds capacity, 150 kilowatts, for ordinary aluminum casting work. It has also designed a large

metal, and that in a reverberatory type aluminum furnace the atmosphere may be made reducing, and that this type can also produce good metal, as well as bad, one is not justified, on present data, in jumping to a conclusion that an electric furnace need be good for aluminum because it may have a reducing atmosphere.

Neither on the score of theory nor of recorded foundry tests of electric aluminum furnaces can assumption be made that any definite direct advantage arises from the electric furnace, save perhaps in the elimination of hard spots in the castings, due to iron scale from the iron pot, an advantage shared by fuel-fired hearth type furnaces as well.

In ease of control, there is a real advantage, because of the great effect that the rate of solidification, i.e., the pouring temperature, has on aluminum. Though it has never been satisfactorily explained, and hardly fully proved, there is a general idea that aluminum, once overheated, in either a reducing or oxidizing atmosphere, is thereby irreparably injured, even though it be poured at the proper temperature. If this be so, then an electric furnace of a type not too sluggish in its response to changes of power input, might be an advantage, and its use should at any rate make careful pyrometric control of pouring temperatures easier.

The General Electric Co. uses a small 75 kilowatt furnace like its older type of electric brass furnace, holding some 75 or 100 pounds of aluminum, to melt a nearly pure aluminum which must flow freely as it must run down through the slots in a motor rotor. This rotor casting is made in an ingenious centrifugal casting machine, and to secure the desired results, the temperature and fluidity of the metal

TABLE III

Electric Furnaces for Nonferrous Melting

Reflected Heat Furnaces

Make	No.	User	Alloy	Capacity tons per heat per furnace	K.W. rating per furnace	Total K.W.	Remarks
Baily	1	Acheson Mfg. Co., Rankin, Pa.	brass and bronze	¾	105	105	
Baily	1	Akron Bronze and Aluminum Co., Akron, O.	brass and bronze	¾	105	105	
Baily	1	Akron Bronze and Aluminum Co., Akron, O.	brass and bronze	¼	50	50	
Baily	1	American Hardware Corp., New Britain, Conn.	brass and bronze	¾	105	105	
Baily	1	Anaconda Copper Mining Co., Butte, Mont.	brass and bronze	¾	105	105	
Baily	1	Atlas Brass Works, Columbus, O.	brass and bronze	¾	105	105	
Baily	2	Buick Motor Car Co., Flint, Mich.	brass and bronze	¾	105	210	
Baily	2	Burlington Brass Wks., Burlington, Wis.	brass and bronze	¾	105	210	
Baily	2	Capitol Brass Co., Detroit	brass and bronze	¾	105	210	
Baily	1	Coppus Engineering and Equipment Co., Worcester, Mass.	brass and bronze	¾	105	105	
Baily	1	Dayton Engineering Labs. Co., Dayton, O.	Al	1/5	105	105	
Baily	2	Dayton Engineering Labs., Co., Dayton, O.	brass and bronze	¼	50	100	
Baily	1	Deming Co., Salem, O.	brass and bronze	¼	50	50	
Baily	3	Detroit Brass Wks., Detroit	brass	¾	105	315	
Baily	1	Drew Electric and Mfg. Co., Cleveland	brass and bronze	¾	105	105	
Baily	1	Hays Mfg. Co., Erie, Pa.	brass	¾	105	105	
Baily	1	Kayline Co., Cleveland, O.	brass and bronze	¼	50	50	
Baily	1	Kennedy Valve Co., Elmira, N. Y.	brass and bronze	¾	105	105	
Baily	1	Landers, Frary and Clark, New Britain, Conn.	aluminum	1/10	50	50	
Baily	2	Lumen Bearing Co., Buffalo, N. Y.	brass and bronze	¾	105	210	
Baily	1	Lumen Bearing Co., Buffalo, N. Y.	Lumen	¼	105	105	

TABLE III—(continued)

Electric Furnaces for Nonferrous Melting

Reflected Heat Furnaces

Make	No.	User	Alloy	Capacity tons per heat per furnace	K.W. rating per furnace	Total K.W.	Remarks
Baily	1	Miller Pasteurizing Machine Co., Canton, O.	brass and bronze	¼	50	50	
Baily	4	Michigan Smelting and Refining Co., Detroit	brass	¾	105	420	
Baily	1	A. Y. McDonald Co., Dubuque, Ia.	brass and branze	¾	105	105	
Baily	1	McKenna Brass Wks., Pittsburgh, Pa.	brass and bronze	¾	105	105	
Baily	1	McKenna Brass Wks., Pittsburgh, Pa.	brass and bronze	¼	50	50	
Baily	3	McRae Roberts Co., Detroit	brass and bronze	¾	105	315	
Baily	2	Nolte Brass Co., Springfield, O.	brass and bronze	¾	105	210	
Baily	1	Ore Metals Co., Los Angeles, Calif.	brass and bronze	¾	105	105	
Baily	1	Penberthy Injector Co., Detroit	brass and bronze	¾	105	105	
Baily	1	Regent Brass Works, Marysville, O.	brass and bronze	¾	105	105	
Baily	1	Rundle Mfg. Co., Milwaukee, Wis.	brass and bronze	½	75	75	
Baily	5	Standard Sanitary Mfg. Co., Louisville, Ky.	brass and bronze	¾	105	525	
Baily	1	S. H. Thomson Mfg. Co., Dayton, O.	brass and bronze	¼	50	50	
Baily	1	Union Metals Mfg. Co., St. Paul, Minn.	brass and bronze	¾	105	105	
Baily	1	Union Screen Plate Co., Fitchburg, Mass.	brass and bronze	½	75	75	
Baily	1*	U. S. Copper Products Co., Cleveland, O.	brass	¾	105	105	nose-tilting
Baily	1	U. S. Navy Yard, Washington, D. C.	brass and bronze	¾	105	105	
Baily	1	Westinghouse Electric and Mfg. Co., E. Pittsburgh, Pa.	brass and bronze	¼	50	50	
Baily	2	West Va. Metal Products Co., Fairmont, W. Va.					
Baily	1*	U. S. Copper Products Co., Cleveland, O.	brass	¾	105	105	nose-tilting
Baily	1	U. S. Navy Yard, Washington, D. C.	brass and bronze	¾	105	105	
Baily	1	Utica Valve and Fixture Utica, N. Y.	brass and bronze	¾	105	105	
Baily	1	Westinghouse Electric and Mfg. Co., E. Pittsburgh, Pa.	brass and bronze	¼	50	50	
Baily	2	West Va., Metal Products Co., Fairmont, W. Va.	brass and bronze	¾	105	210	nose-tilting
Baily	1	White and Bros., Philadelphia	brass and bronze	¾	105	105	
	65**					5950	
General Electric Co.	1	General Electric Co., Schenectady, N. Y.	aluminum	1/20	75	75	
General Electric Co.	1	General Electric Co., Schenectady, N. Y.	aluminum	2/5	150	150	
General Electric Co.	1	General Electric Co., Schenectady, N. Y.	brass and bronze	1¼	400	400	
General Electric Co.	1	Ohio Brass Co., Mansfield, O.	brass and bronze	1¼	400	400	
General Electric Co.	1	U. S. Copper Products Co., Cleveland	brass and bronze	1¼	400	400	
General Electric Co.	1	U. S. Navy Yard, Washington	brass and bronze	1¼	400	400	
	6***					1825	

* Furnace soon to be moved to Parish-Pool Co., Cleveland,
** 48—105 K.W.; 2—75 K.W.; 10—50 K.W.; about 50 of these were already installed June 1.
*** 2 of these not yet installed.

furnace of the same general type, holding several tons which it hopes to try out experimentally. The design calls for a long, rather narrow hearth with a weir or a dividing wall with a hole in it, about half way up, between the two parts of the hearth. Metal is to be charged at the back, melted, and clean metal, free from dross floating on top, or from foreign particles heavier than the metal, is to run through into the fore part. The rate of melting in the rear part of the hearth and of superheating to pouring temperature in the fore part may be regulated by changing the position of the electrodes along the front or rear, to generate more or less power as desired. This scheme offers some possibilities, but they must be tried out before their value is certain.

The General Electric Co. is building still another type of electric aluminum furnace to be tried at the Pittsfield, Mass., plant. This is a rectangular tilting furnace, like a long box, the hearth occupying the lower part, the heating element being strips of nickel-chromium resistance ribbon, such as is used in the heat-treating furnaces for gun-forgings.* The heating element is placed not only in the roof proper but also on the sides, above the hearth. Such a resistor will not stand operation at temperatures sufficient to melt brass, but it may handle aluminum at a repair cost that will not be prohibitive. One factor leading the General Electric Co. to build this type was a desire to secure comparative data on the effect of the oxidizing atmosphere this furnace will have against that of the reducing atmosphere in the arc-resistance type used both for brass and aluminum.

The General Electric arc-resistance furnaces for use on aluminum are the same as for brass, except that the transformer capacity and power input are lower for the same size shell, than on brass. They give the following table, for different sizes:

Kilowatts	Hearth capacity lbs.	Nominal lbs. melted per hour	Approx. kilowatt hours per ton
		On basis of 24 hour operation, i. e., after furnace is fully hot	
100	300	250	600
150	800	500	525
200	1000	750	500
300	1400	1200	500

One Baily standard 150 kilowatt furnace is operating regularly on No. 12 aluminum at the plant of the Dayton Engineering Laboratories Co., Dayton, O. A test run on the furnace showed an output of about 1½ tons per day in 8½ hours actual melting, plus 1 hour preheating the furnace or seven to eight heats of 425 pounds each. The average power consumption ran from 625 to 675 kilowatt hours per ton. The

*Johnson, L. F., How the power house aids the forge, Iron Trade Review, 1919, p. 1223.

average power input was only 80 kilowatts. Twenty-four-hour operation figures cannot be extrapolated from the data as reported. The users are well satisfied with the operation.

At the plant of Landers, Frary and Clark, New Britain, Conn., one of the 50 kilowatt rectangular Baily furnaces was operated for about two months before it was taken out on account of trouble in maintaining the resistor trough. It later was replaced by the round type of the same make. This furnace, melting 9 hours per day and being preheated 4 hours gave on 150-pound heats, gave an output of ½ ton per day, at 850 kilowatt hours per ton. The net metal loss was about 0.7 per cent.

One of the 150 kilowatt Baily furnaces was tried out some years ago by the Aluminum Co. of America for making ingot from pig aluminum, but was not kept in service, being considered too small for that type work.

A big 500 kilowatt tapping type Baily furnace later was installed at the plant of the United States Aluminum Co., Massena, N. Y. This has been described by Miller.* It had two straight resistors, one on each side of the hearth, and held 3 to 4 tons of aluminum. In this furnace, according to the users,** under best conditions and continuous operation the production was about 1 ton per hour at slightly under 500 kilowatt hours per ton. The furnace primarily was installed for making alloys high in zinc, and on such service it showed a notable decrease in metal loss over fuel-fired reverberatory furnaces. However, on the regular run of aluminum there was no decrease in metal loss. The resistor troughs have been a source of trouble, failing frequently, and the high heat capacity of the furnace makes it less efficient on intermittent operation, the power consumption averaging some 700 kilowatt hours per ton on the furnace as actually operated over a period of time.

As a consequence of the high power consumption the use of the furnace has been practically given up, and its owners contemplate changing it over to an annealing furnace, since such furnaces give satisfactory results at the lower operating temperatures used in annealing.

It should be mentioned that a 105-kilowatt Baily furnace long has been in satisfactory operation at the Lumen Bearing Co., Buffalo, on an alloy of

*Miller, D. D., The remelting of aluminum pig in the electric furnace, Chem. and Met. Eng., Vol. 19, 1918, p. 251.

**Vail, A. E., personal communication, Jan. 21, 1920.

TABLE V
Electric Furnaces for Nonferrous Melting

Contact Resistance Furnaces

Make	No.	User	Alloy	Capacity tons per heat per furnace	K.W. rating per furnace	Total K.W.
Bennett	6	Scovill Mfg. Co., Waterbury, Conn.	brass and copper	1	150	900
Bennett	1	Scovill Mfg. Co., Waterbury, Conn.	brass and copper	5	500	500
	7					1400

Crucible Furnaces

Baily	1	W. A. Rogers Ltd., Niagara Falls	silver	about 65 Lbs.	40	40
Ajax Northrup	1	Baker and Co., Inc., Newark, N. J.	platinum	.....	20	20
Ajax Northrup	1	J. R. Wood and Sons New York City	gold	.....	20?	20
Ajax Northrup	2	U. S. Mint, Philadelphia	gold and silver	about 75 Lbs.	8	16
Ajax Northrup	2	U. S. Mint, Philadelphia	gold and silver	about 190 Lbs.	16	32
Ajax Northrup (tilting)	1	Handy and Harmon, Bridgeport, Conn.	silver	600 Lbs.	60	60
	8					188

TABLE IV
Electric Furnaces for Nonferrous Melting

Vertical Ring Induction Furnaces

Make	No.	User	Alloy	Capacity tons per heat per furnace	K.W. rating per furnace	Total K.W.
Ajax-Wyatt	3	Ajax-Metal Co., Philadelphia	yellow brass	⅙	30	90
Ajax-Wyatt	32*	American Brass Co., Waterbury, Conn.	yellow brass	⅓	60	1920
Ajax-Wyatt	24**	American Brass Co., Torrington, Conn.	yellow brass	⅓	60	1440
Ajax-Wyatt	24	American Brass Co., Kenosha, Wis.	yellow brass	⅓	60	1440
Ajax-Wyatt	1	American Hardware Co., New Britain, Conn.	yellow and red	⅙	30	30
Ajax-Wyatt	6	Baltimore Tube Co., Baltimore, Md.	yellow brass	⅓	60	360
Ajax-Wyatt	24	Bridgeport Brass Co., Bridgeport, Conn.	yellow brass	⅓	60	1440
Ajax-Wyatt	21***	Bridgeport Brass Co., Bridgeport, Conn.	yellow brass	¾	80	1680
Ajax-Wyatt	1	Buick Motor Car Co., Flint, Mich.	yellow brass	⅓	60	60
Ajax-Wyatt	31****	Chase Rolling Mill Co., Waterbury, Conn.	yellow brass	⅓	60	1860
Ajax-Wyatt	1	General Electric Co., Schenectady, N. Y.	yellow brass	⅓	60	60
Ajax-Wyatt	6	National Conduit and Cable Co., Hastings, N. Y.	yellow brass	⅓	60	360
Ajax-Wyatt	1	Raritan Copper Works, Raritan, N. J.	yellow brass	⅓	60	60
Ajax-Wyatt	1	Parish-Pool Co., Cleveland, O.	yellow brass	⅓	60	60
Ajax-Wyatt	1	Rome Brass and Copper Co., Rome, N. Y.	yellow brass	⅓	60	60
Ajax-Wyatt	1	Scovill Mfg. Co., Waterbury, Conn.	yellow brass	⅓	60	60
Ajax-Wyatt	1	Stamford Rolling Mills Co., Stamford, Ct.	yellow brass	⅓	60	60
Ajax-Wyatt	1	W. A. Clark Wire Co., Bayway, N. J.	yellow brass	⅓	60	60
Ajax-Wyatt	6	West Va. Metal Products Co., Fairmont, W. Va.	yellow brass	⅓	60	360
Ajax-Wyatt	1	U. S. Navy Yard, Washington, D. C.	yellow brass	⅓	60	60
	187*****					11520

* Including 16 not installed but planned for.
** Not yet installed but planned for.
*** Only one of these is yet installed. The 20 planned for is approximate.
**** Only one of these is yet installed.
***** Only 93 of these are yet installed.

Horizontal Ring Induction Furnaces

	1	Hoskins Mfg. Co., Detroit	nickel alloys	⅓	100	100

approximately 85 per cent zinc, 10 per cent copper, 5 per cent aluminum, which is poured at about 700 degrees Cent. The furnace gives about 5500 pounds per 10-hour melting day, using about 660 kilowatt hours in the daytime and 330 at night to keep the furnace hot, *i.e.*, about 360 kilowatt hours per ton on this low-melting alloy.

A few isolated heats of aluminum have been made in Snyder direct arc furnaces, but no data of consequence appear to have been kept, and none are available. If the direct arc furnace will produce a satisfactory quality of metal, without undue gas absorption in the overheated metal under the arc, such a furnace should work well, since the common aluminum alloys, outside of the zinc-containing alloys, are relatively nonvolatile, and direct arc furnaces are useful for such alloys. This question should be investigated, and the bureau of mines hopes to study it.

The Rennerfelt indirect arc furnace in a small 50 kilowatt size was used in making up the hardeners used by the Acieral Co. of America, but not in melting the aluminum alloy itself, before that firm went out of business. Similar hardeners now are handled in a similar furnace, but of 100 kilowatt capacity at the Bausch Machine Tool Co., Springfield, Mass. No real tests of stationary indirect arc furnaces on aluminum alloys themselves are on record. However, on the basis of some small test runs in the 50 kilowatt furnace, made by starting with the furnace at the temperature used for making hardeners, and therefore well above aluminum temperatures, it was calculated that in a 1-ton furnace 310 kilowatt hours would be required, presumably on 24-hour operation. These figures later were revised to 350, but neither figure is based on adequate test.

One of the standard Detroit rocking furnaces rated at 300 kilowatts was given a thinner lining than for use on brass, the melting chamber being 49 inches diameter by 41 inches, the furnace thus lined holding 1700 pounds of aluminum, and tested at the C. B. Bohn Foundry Co., Detroit. The power input was raised to 325-375 kilowatts, and on about 60 tons of No. 12 the actual melting time averaged about 1 hour, 10 minutes per heat, corresponding to an output of about 5 tons per 10-hour day, at about 475 kilowatt hours per ton. The 24-hour melting rate would approach 375 kilowatt hours per ton. The net metal loss averaged about 0.85 per cent, running about 0.45 per cent on American ingot, scrap No. 12 and gates, and up to 1.3 per cent on some French ingot that appeared to contain some nonmetallic impurities that weighed in as metal, though it is also possible that there was in this case some formation of aluminum carbide due to piling the charge too close to the arc in the runs on French metal which were made first. The product from both the French and American metal was of satisfactory quality. The furnace is used for making up the copper-aluminum hardener, as well as for No. 12 alloy.

The Ajax-Wyatt induction furnace has not been tried on aluminum.

It will be noted that all the data on aluminum shows a high power consumption per ton of metal compared to that required by the same furnace on brass. The figures range on 10-hour operation from 850 kilowatt hours per ton in the 50-kilowatt Baily on 150-pound heats through 650 kilowatt hours per ton in the 105-kilowatt Baily on 425-pound heats, to 475 kilowatt hours per ton in the 375 kilowatt Detroit on 1700-pound heats. The 24-hour operation figures for the 3 to 4-ton Baily tapping furnace and for the 1000 to 1400-pound General Electric furnaces, are 500 kilowatt hours per ton, under best conditions. Roughly, a given size and type of furnace requires at least 50 per cent more power per ton to heat aluminum to 700 degrees Cent. than it does yellow brass to 1050 degrees Cent.

In fact, theory calls for the expenditure of about twice as much energy, since, averaging the available data, 100 per cent melting efficiency calls for about 150 kilowatt hours per ton for yellow brass,* and about 300 kilowatt hours per ton for No. 12 aluminum.

In fuel-fired furnaces, the difference in fuel consumption is not so marked because such furnaces operate at a higher efficiency the lower the temperature, so that a given fuel-fired furnace probably can produce a ton of aluminum with not much more fuel than it would use on yellow brass.

Without the savings in metal losses and in crucibles shown in brass melting, without definite proof of improved quality of metal, the value of electric furnaces for aluminum depends primarily on whether or not an aluminum melter can pay around $7 to 10 or more per ton, depending on the cost of power and the size and type of electric furnace chosen, for electric power to melt his metal, plus the interest and depreciation charges per ton on an ex-

TABLE VI
Furnaces for Nonferrous Melting
Totals by Types

Type	Make	Approx. No. actually installed June	Approx. No. actually installed for copper, brass and bronze	Total No. including those being installed and on order June 1	Total capacity of all per heat Tons	Total No. for copper, brass and bronze	Total K.W.H. of all
Direct arc	Heroult Snyder Greaves-Etchell	11	2	11	7½	2	3500
Stationary Indirect Arc	Rennerfelt	7	6	7	4½	6	1375
Moving Indirect Arc	Detroit	40	39	50	46	49	13800
Moving Indirect Arc	Booth	10 (est)	10 (est)	35	9	35	4720
Moving Indirect Arc	American	1	1	1	½	1	300
Reflected heat	Baily	50	47	65	41½	57	5950
Reflected heat	General Electric	4	4	6 or more	5½	4	1825
Induction Vertical Ring	Ajax Wyatt	93	93	187	70½	187	11520
Horizontal Ring Induct.	Hoskins	1	0	1	⅛	0	100
Contact Resistance	Bennett	7	7	7	11	7	1400
Crucible	Ajax-Northrup and Baily	7	0	8	under ½	0	188
Ni-Cr Resistor for aluminum	General Electric	0	0	1	⅛ (est)	0	100 (est)
		231	209	379	196¾	348	44858

Compare Richards, J. W., Electric Power Required to Melt Metals, Trans. Am. Brass Founder's Assn., Vol. 4, 1910, p. 95; Clamer, G. H., and Hering, C., The Electric Furnace for Brass Melting, Trans. Am. Inst. Metals, Vol. 6, 1912, p. 101; Hansen, C. A., Electric Melting of Copper and Brass, Trans. Am. Inst. Metals, Vol. 6, 1912, p. 112. Also unpublished data from Bridgeport Brass Company.

pensive furnace which will give only a small output, compared to brass, of the light metal, aluminum, and still beat his present fuel costs.

The various electric furnaces for melting nonferrous metals now in use and being developed have been described, though many early ones that fell by the wayside, through whose failure much has been learned, have not been included. It is of interest to see how many furnaces, and of what types, are among the live ones in the United States, and the accompanying tables, which include only those furnaces that can fairly be said to be in actual operation or which are on definite order or definitely planned for by the management of a plant and are so reported by the plant, therefore has been prepared. Smelting rather than melting furnaces, of which there are a few on nonferrous work, to say nothing of the electrolytic cells used in the production of aluminum, are not included.

The tables show that on June 1, 1920, there were actually installed and regularly operating about 210 electric brass furnaces and some 20 other nonferrous electric furnaces, taking a total of over 30,000 kilowatts, *i.e.*, equivalent to about a third the total generating capacity of the famous Connor's creek generating station of the Detroit Edison Co.

Around 170 more furnaces were on order or definitely planned, and while adverse business conditions may postpone some of the installations, especially the large installations of Ajax-Wyatt furnaces contemplated by three rolling mill firms, yet most of these are expected to go in eventually. If one cared to add to the total by including small furnaces used intermittently for laboratory work, those for demonstration purposes, and the various experimental furnaces under more or less active development, he might state that in 1920, nonferrous alloys probably will be melted in about 400 different electric furnaces. The natural growth of electric brass melting may really bring it to that figure.

It is quite certain that the end of 1920 will see in commercial operation more electric brass furnaces in the United States than electric steel furnaces. By that time the power used in electric brass melting will be well over 10 per cent of the electric power used by the city of Detroit, and the foundrymen of the United States will have invested around $2,500,000 in electric brass furnaces.

When all these furnaces are in operation, they may be expected to use roughly 100,000,000 kilowatt hours per year, which will cost, roughly $1,000,000. They should produce roughly 250,000 to 333,000 tons of metal, or say a third to a half of the total amount melted. All these calculations depend on whether the furnaces are run 24 hours a day or only eight to 10 hours, and on many other factors, but they serve at least to show the order of magnitude.

TABLE VII

Furnaces for Nonferrous Melting

Other Electric Brass and Aluminum Furnaces being Developed

Name	Type	Inventor or Developer
Foley	Vertical Ring Induction	C. B. Foley—Bristol Brass Co., Bristol, Conn.
Rennerfelt	Reflected	H. A. DeFries—Hamilton and Hansel, Inc.,
Reverberatory	Heat	Park Row Building, N. Y. City.
Thomson	Moving, zig-zag solid resistor	John Thomson, 253 Broadway, N. Y. City.
Industrial	Not known, 3-phase self regulating phase	Industrial Electric Furnace Co., 53 W. Jackson Blvd., Chicago, Ill.
Moore	Moving indirect Arc	Pittsburgh Electric Furnace Corp., Union Bank Bldg., Pittsburgh, Pa.
Reardon	Moving indirect Arc (converter open flame oil furnace)	W. J. Reardon, Aluminum Manufacturers, Inc., Detroit, Mich.
General Electric Co.	Nickel-chromium resistor furnace for aluminum	E. F. Collins, General Electric Co., Schenectady, N. Y.
Stassano-Petinot	Stationary Indirect Arc	N. Petinot, U. S. Ferro Alloys Corp., 30 E. 42nd St., N. Y. City.

Total different types or makes of electric furnaces for nonferrous metal in commercial use in the United States	14
Total other types or makes being developed	8
Total distinct types or makes suggested or tried for nonferrous melting, over	80

Furnaces Sold to Foreign Countries by United States Makers

Make	Firm	Location	Alloys Melted
Heroult	Hiram Walker Metal Products Co.	Walkerville, Ont., Canada	Nickel alloys
Greaves-Etchell	Government Mint	Japan	Bronze and silver
(Electric Furnace Construction Co., Phila.)	Lacheze et Fils	Dijon, France	Non-ferrous
Baily	G. Amsinck Corp.	Mexico City, Mexico	Brass and bronze (2-105 K.W. each furnaces)
Baily	Dominion Steel Products Co.	Brantford, Ont., Canada	Brass and bronze (50 K.W.)
Baily	Mitsui and Co.	Japan	Brass and bronze (105 K.W.)
Baily	Allen and Everett	Birmingham, Eng.	Brass and bronze (105 K.W.)
Detroit	Furakawa Mining Co.	Japan	Brass and bronze (75 K.W.)
Detroit	Kobe Steel Co.	Japan	Brass and bronze (105 K.W.)
Detroit	Mitsubishi Co.	Japan	Brass and bronze (75 K.W.)
Detroit	Schneider & Co.,	Creusot, France	Brass and bronze (105 K.W.)

Total nonferrous electric furnaces of United States make sold for use in other countries	12
Number plants in U. S. employing or having ordered electric furnaces for nonferrous melting	118
Number of plants in U. S. employing 2 or more electric furnaces for nonferrous melting	40
Number plants in U. S. employing 2 or more different types or makes of electric furnace for commercial nonferrous melting	16
Approximate number of nonferrous electric furnaces made abroad and used abroad, mostly Rennerfelts—about	30

With 50 per cent more furnaces in actual operation than its nearest competitor and being scheduled to make up 50 per cent of the total number of all furnaces installed, the Ajax-Wyatt furnace leads in numbers, and may be fairly said to have revolutionized melting methods in the wrought brass industry. The Detroit rocking furnace leads in total kilowatts connected, and in output as well, though, as most of that type operate but 10 hours while the Ajax-Wyatt operates 24, the latter closely approaches the Detroit in output now, and will surpass it when all the Ajaxes planned for are in operation. The Baily furnace is second in numbers and is close in connected kilowatts to the present actually installed Ajaxes, but in total production is behind the Detroit and the Ajax. The Booth furnace is climbing steadily.

THE FOUNDRY

A semimonthly journal devoted to all branches of the foundry trade

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

BRANCH OFFICES

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FOREIGN OFFICES

BIRMINGHAM, Eng.....Prince's Chambers
LONDON, Eng., 2-4 Caxton House, Westminster

Cable address, IROTRAPEN, London.

SUBSCRIPTION

United States and Mexico.....$2.00 a year
Canada .....$3.00 a year
Great Britain and other Foreign Countries.....$4.00 a year
Single Copies .....25 cents

Copies published three months or more previous to date of current issue, 50 cents each

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 1st and 15th of the month preceding date of publication.

Member, the Audit Bureau of Circulation and Associated Business Papers Incorporated

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Expanding Foreign Service

TO PROVIDE larger and better facilities of a permanent character for the growing requirements of our European division, the London office of THE FOUNDRY will be moved on July 1 from 16 Regent street to 2-4 Caxton House, Westminster, London, S. W. 1. Correspondence for our European office should be addressed to Caxton House hereafter, together with that for the affiliated publications of The Penton Publishing Co., which include the *Daily Iron Trade and Metal Market Report, The Iron Trade Review, Marine Review, Power Boating* and *Abrasive Industry*.

As a result of this change, greatly improved facilities will be provided for transacting all of the European business of THE FOUNDRY. Caxton House, which is one of the leading modern office buildings in London, is located in the heart of the Westminster iron, steel, marine and engineering district. It is within a block of the headquarters of the British Iron and Steel institute, Institution of Mechanical Engineers, Institution of Civil Engineers, Institute of Metals, etc. Within a short distance also are located the houses of parliament, British government offices, and the offices of many of the largest iron, steel, shipbuilding and engineering firms in Great Britain, together with the European offices of many large American iron, steel and machinery corporations.

American business men traveling to England are cordially invited to make their headquarters at our London offices. During the coming summer season special facilities will be available for taking care of mail, which may be addressed in care of our European headquarters. Other arrangements are being made to look after the requirements of business visitors and we hope this will be considered as a personal invitation by any of our readers, friends or advertisers who may be going abroad.

What Is Good Coke

ALTHOUGH coke is one of the most essential items entering into casting production, foundrymen generally have given it little consideration from a technical standpoint. Of course, the practical foundryman knows in his own case which of the available products gives the best results, but does he know whether it would be possible to improve on his favorite fuel or whether some new coke would not give still better results in his cupola? The question of foundry coke, considered from the manufacturing end has been treated in the literature of the past few years, but there has been a marked absence of anything of a scientific nature describing the coke which should be used in the foundry to produce the best results. So far, practically all that has been done in this connection has been fostered by the coke producers themselves. Of course, a wide range of size and composition in coke may be possible without materially affecting the results in the cupola, but if this is so, it should be known and tested by the foundryman and not left to the coke producer. In a paper appearing in this issue, the author, who is engineer for a coke company, shows something of what is being done to improve the nature and quality of foundry coke, but he is frank to admit that he does not know just what will produce the best results in the foundry. Undoubtedly, thought should be given to this question for coke companies have shown themselves eager in the past to assist.

Trade Outlook in the Foundry Industry

COKE scarcity will become more acute during the late summer, fall and winter. This is the composite expression of opinion voiced both by producers and large users of this fuel. At present the foundryman who is receiving 50 per cent of his contract allotment of coke is favored. With a continuing and aggravated car shortage, 50 per cent is an outside estimate of the cars available for coke shipment, and road delays enroute still continue in many sections. Therefore, that foundry which is receiving one-half of its normal requirements is fortunate.

Market Is Wild

The acute scarcity which impends has driven coke prices steadily upward. Spot foundry coke is quoted at $15 to $17 ovens, and some has been sold at above $20 a ton. July 1, which marks the termination of the first half contracts for coke finds few stable agreements for last half delivery. Users, in general, share with producers a reluctance to enter into contracts covering the entire six months. A number of sales have been made for last half coke, based upon a sliding scale which in turn rests upon advancing coal prices. At a season when, ordinarily, foundries would be secure as to price and delivery for the fall and winter, and when a reserve against winter traffic delays would be well established, little activity is noted. While shops in general have been able to maintain a day-to-day supply of fuel, no surplus is to be had. Anxiety regarding supplies of iron and coke, has led foundrymen to neglect sand, in some instances. Preferential distribution of cars, has not taken into account the essential character of molding sand. Consequently traffic committees representing foundries in some of the larger centers are acting to secure shipment on at least a small reserve of sand before the winter.

Prices of Raw Materials for Foundry Use

CORRECTED TO JUNE 25

Iron		Scrap	
No. 2 Foundry, Valley	$44.00	Heavy melting steel, Valley	$25.00 to 26.00
No. 2 Southern, Birmingham	40.00 to 42.00	Heavy melting steel, Pittsburgh	25.50 to 26.00
No. 2 Foundry, Chicago	44.00 to 45.00	Heavy melting steel, Chicago	23.00 to 23.50
No. 2 Foundry, Philadelphia	45.60 to 48.10	Stove plate, Chicago	31.50 to 32.50
Basic, Valley	44.50 to 45.00	No. 1 cast, Chicago	41.00 to 41.50
Malleable, Chicago	43.50	No. 1 cast, Philadelphia	37.00 to 39.00
Malleable, Buffalo	46.25	No. 1 cast, Birmingham	30.00 to 33.00
Coke		Car wheels, iron, Pittsburgh	38.00 to 39.00
Connellsville foundry coke	15.00 to 17.00	Car wheels, iron, Chicago	35.50 to 36.00
Wise county foundry coke	12.00 to 12.50	Railroad malleable, Chicago	28.75 to 29.25
		Agricultural malleable, Chicago	28.50 to 29.00

Conservation Imperative

Many foundries at present are melting with a low ratio of coke to iron established in the days when coke was $6 per ton, and when a few hundred weight of fuel per charge made little impression upon the per pound cost of castings. With increasing coke prices, the same ratio has been maintained, many regarding the extra cost as a premium on insurance against dull iron. The problem now has passed beyond a matter of unit cost of castings. Coke production is decreasing week by week. Scanty supplies of cars in which to ship from the ovens have been still further restricted through a recent order of the interstate commerce commission which provides that coal cars must be used exclusively for coal, and may not be reloaded with coke at the ovens. This will further restrict coke output. Therefore, disregarding the cost factor, a longer melting ratio must obtain if gray-iron castings production is not to suffer a severe contraction. Where 4 to 1 charges have been used, 8 to 1 or even 10 or 12 to 1 should be adopted if the class of work handled will permit this conservation. Those who are receiving coke shipped within the past 30 or 60 days report a great deterioration in quality. The ash content which normally does not exceed 6 per cent has mounted to 12 to 14 per cent. Sulphur is high, and the amount of breeze and fine material is immeasurably increased. The reason for these shortcomings in the fuel is directly traceable to the car shortage. The former 72-hour by-product coke is practically unknown at present. When cars are available, the ovens are pushed at from 40 to 50 hours after they are charged, in order that the tracks may be cleared and new cars placed as quickly as they become available. On the other hand, when no cars are available, the coke time must necessarily be extended, as only a small amount of storage space is available. This produces an inferior quality of coke which is easily broken down in handling. Beehive producers although faced by different problems, are hampered by shortage of cars in a similar degree. Although few cancellations have been received, a marked slackening in demand for gray iron castings is noted. This condition is not taken to indicate the approach of over production, but rather a temporary lull induced by transportation difficulties experienced by the large users of castings. Many foundries continue to have difficulty in shipping their finished product, through inability to secure cars, although when once loaded, transportation to destination is fairly satisfactory.

Costs Block Construction

Curtailment of building activities, due to high prices, has lessened the demand for plumbing goods and other domestic castings. Cast iron pipe also, is not active, due to the inability of municipalities to finance new undertakings. The production schedules of passenger automobile manufacturers has been slightly abridged. It is hoped that the output may not fall below 65 per cent of the early 1920 estimates, but a cut of at least 35 per cent is expected. Tractor and truck building companies have not been obliged to curtail their programs, although at present some difficulty is experienced in securing materials. Prices of nonferrous metals based on New York quotations follow: Copper, 17.62½c to 17.75c; lead, 8.50c; tin, low: Copper, 17.62½c to 17.75c; lead, 8.50c; tin, 46.25c to 46.50c; antimony, 7.50c to 7.62½c; aluminum, No. 12 alloy, producers' price, 32.00c and open market, 31.00c. Zinc is quoted at 7.40c to 7.45c, St. Louis.

Comings and Goings of Foundrymen

JAMES A. GALLIGAN, sales agent for Pickands, Brown & Co., Chicago, for the past 12 years, has been appointed sales manager and assistant to Vice President C. D. Caldwell of the By-Products Coke Corp. at Chicago. The sale of coke by Pickands, Brown & Co., which has been in his charge, has been assumed by R. S. Dutton, manager of sales for all departments. F. L. Schulze has been appointed assistant sales agent for the coke department. Mr. Galligan's experience of 12 years in selling the output of the western coke plants has given him wide insight into the production and distribution of coke, a fact recognized when he was appointed in April, 1918, as district representative in charge of coke distribution in the Middle West under the United States fuel administration. In this position he allocated the output of all plants in Indiana, Illinois, Wisconsin and Missouri. Mr. Galligan is a native of Milwaukee and is 45 years of age. He began his business career at 16 years as a stenographer and in 1899 entered the employment of the Edward P. Allis Co., Milwaukee. Two years later was made manager of the Elizabeth Mining Co. in the Black Hills, which was owned by Mr. Allis. In 1902 he joined the staff of the Allis Chalmers Co., Milwaukee, advancing to assistant general purchasing agent. In 1906 he became salesman for Pickands, Brown & Co., in their Milwaukee office, being transferred to their Chicago office two years later to have charge of coke sales.

G. W. Price, formerly superintendent of the gray iron and steel foundries of the Lenoir City Car Works, Lenoir City, Tenn., has been appointed superintendent of the gray iron and steel foundries operated by the Anniston Steel Co., Anniston, Ala.

C. D. Gilpin now is works manager of the Detroit plants of the Aluminum Manufactures, Inc., Cleveland. He has been with the company about eight years, commencing as timekeeper.

James Anderson recently assistant foundry foreman of the Morgan Engineering Co., Alliance, O., has been made assistant superintendent for the Edgewater Steel Corp., Oakmont, Pa.

W. E. Warner, who for a number of years has been associated with the Lumen Bearing Co., Buffalo, has been made superintendent of the new plant of that company at Youngstown, O.

C. S. Siebert recently has been appointed district sales manager in Cincinniati for the Iron Trade Products Co., Pittsburgh.

T. E. Malone, J. S. McCormick Co., Pittsburgh, has resumed his duties with this company after an absence of several months owing to ill health.

G. A. Weisgerber has been promoted to the position of purchasing agent

JAMES A. GALLIGAN

of Stanley G. Flagg & Co., Philadelphia, to succeed J. M. Mather, who recently resigned his position to engage in other activities.

Edward C. Waldvogel, who for the past four years has been general manager in charge of sales and advertising for the Yale & Towne Mfg. Co., has been elected on the directorate of that organization.

E. H. Williams, who recently resigned as a colonel from the United States army, has been appointed manager of service and inspection departments of the Valley Mould & Iron Corp., Sharpesville, Pa.

Fred Thornley, director and works manager, W. Thornley & Sons, Ltd., Sydney, Australia, is visiting this country to purchase equipment and supplies for his company's newly completed foundry. Mr. Thornley, until Aug. 1, will be located at the Highland Court Hotel Hartford, Conn.

E. F. Stone recently has resigned his position with the Medicine Hat Pump & Brass Co. to become foundry foreman for the Coppus Engineering Co., Worcester, Mass., manufacturer of steam turbines.

Alton N. Bates, vice president and general manager of the Erie Foundry Co., Erie, Pa., will return shortly from an extensive trip to England, France and Italy. He has been abroad for the past three months in the interest of his concern.

A. F. Stirling Blackwood recently resigned his position as vice president, general manager and director of the Union Steel Casting Co., Boston. Mr. Blackwood has organized a company to make steel castings utilizing a new type of melting furnace.

George P. Mills, formerly electrical sales engineer for the General Electric Co., Philadelphia, has been placed in charge of a department established to develop electrical heating furnaces for industrial use, by the Electric Furnace Construction Co., Philadelphia.

Willard A. Case recently has been elected treasurer succeeding John B. Milliken, who resigned his office as treasurer of the Yale & Towne Mfg. Co., Stamford, Conn. Mr. Case recently has been advisory engineer to the Audit Co., New York, which specializes in problems of operating management and accounting.

J. M. Mather has resigned as purchasing agent of Stanely G. Flagg & Co., Philadelphia and Pottstown, Pa., to become connected with the purchasing departments of the Central Foundry Co., 90 West street, New York, which also handles the sales of the pig iron output of the Central Foundry Co.'s southern furnaces.

Keith A. Wood, Malden, Mass., formerly New England district man- of electric industrial tractors, has been appointed manager of the electric truck division of the Cowan Truck Co., Holyoke, Mass. I. T. Hughes, who has represented the Cowan Truck Co. in New York state, has been promoted to sales manager of the hand truck division.

Allan F. Goodhue recently has been elected vice president in charge of sales for the Chicago Pneumatic

Tool Co., Chicago. Since May 1, 1919, Mr. Goodhue has been managing director of the company's English subsidiary, the Consolidated Pneumatic Tool Co., London, and also director of European sales for the Chicago company. Mr. Goodhue formerly was with the Midvale Steel Co. and Midvale Steel & Ordnance Co. in Philadelphia, Chicago and Boston. During the war he was assistant manager of the steel and raw material section, production division, of the Emergency Fleet Corp.

R. A. Sleicher, formerly vice president of the Edward A. Cassidy Co., New York, and prior to his affiliation with that corporation, vice president of the Troy Foundry & Machine Co., Troy, N. Y., has been appointed general manager of the Standard Process Steel Corp., Phillipsburg, N. J. The manufacture of steel castings at this plant has been discontinued and the entire facilities of the shop now are devoted to the production of both light and heavy gray iron castings. Equipment also is provided for machining the castings produced. A large number of molding machines now are being installed for the production of light work.

Hold Joint Meeting

At the invitation of the Connecticut Foundrymen's association, the New England Foundrymen's association met with it in joint session at Hotel Garde, Hartford, Conn., recently. The former association is less than a year old and the joint meeting therefore is the first of its kind. J. E. Stickler, president of the Connecticut association opened the session with a welcome to the members of the larger organization. He gave a brief description of the work and scope of the Connecticut association. The New England association is purely a social affair and the Connecticut foundrymen feeling a need for some combined effort to meet the many problems which arise in their industry, organized the Connecticut Foundrymen's association in June, 1919. The meetings of this association are conducted as open forums for the discussions of any topics pertinent to the business of manufacturing castings. Interest in the new association is active and over 80 per cent of the membership has been present at every meeting throughout the past year. Mr. Stickler said he felt that similar associations should be formed in Massachusetts and Rhode Island and that the three should be affiliated and co-ordinated in a revised New England Foundrymen's association. The principal paper of the evening was that of Thomas Kelly, manager of the Hartford County Manufacturers association. He described the association's work and told of the healthy condition of manufacturing plants throughout the Hartford district. Clifford Lovell, of Walker-Pratt Manufacturing Co. and vice-president of the New England Foundrymen's association spoke in behalf of the president and of the association members and thanked the Connecticut foundrymen for their hospitality. Other speakers were Robert E. Newcomb, former president of the New England Foundrymen's association and F. B. Farnsworth, of the McLagon Foundry Co. New Haven, Conn.

ALLAN S. BIXBY

Pittsburgh Foundrymen Observe Field Day

Combined with the annual outing and ladies' day of the Pittsburgh Foundrymen's association held at The Pines, Monday, June 21, was the installation of officers for the 1920-1921 term. A series of athletic events added to the gaiety of the occasion and the annual baseball contest between the foundrymen and supplymen was decided in favor of the former.

"Co-operation" was the subject of a forceful and instructive address delivered by George D. McIlvaine, of Pittsburgh. He directed attention to the co-operative spirit among business men engendered by the prosecution of the war and pointed out the need for legislation that will permit the continuation of such co-operative effort without danger of violating existing statutes governing combinations.

The following officers were installed: President, A. J. Hartman, United Engineering & Foundry Co.; vice president, F. H. Clay, Allegheny Steel Co.; treasurer, William J. Brant and secretary, Bayard Phillips, Phillips & McLaren Co.

The executive committee for the ensuing year are: A. M. Fulton; John Field, Union Steel Casting Co.; John W. Gray, Fort Pitt Steel Casting Co.; J. S. McCormick, J. S. McCormick Co., and H. P. Spilker, Sterret-Thomas Foundry Co. Foundry fund trustees are W. J. Brant.; C. H. Gale, Pennsylvania Malleable Co. and J. Lloyd Uhler, Union Steel Casting Co.

The following committee was in charge of the outing: A. C. Dobson, Carborundum Co.; G. A. Bauman, Jones & Laughlin Steel Co.; C. L. Kirk, Kirk Supply Co. and L. W. Mesta, Mesta Machine Co.

Obituary

Allan S. Bixby, manager of the Indianapolis plant of the National Malleable Castings Co., Cleveland, and prominent in the malleable castings industry, died at his home in Indianapolis, June 12, aged 50 years. The immediate cause of death was meningitis which had followed an attack of bronchial pneumonia extending over several weeks. Mr. Bixby was born in Philadelphia in 1870 and was graduated from the Rose Polytechnic institute in 1892. He immediately became connected with the Ewart Mfg. Co., of Indianapolis, now known as the Link-Belt Co.

He eventually became superintendent of the Ewart company. In 1902 he became associated with the National Malleable Castings Co., as superintendent of the Indianapolis plant, and in July, 1916, was made manager, which position he occupied at the time of his death. Mr. Bixby was a member of the Indianapolis chamber of commerce and several Indianapolis clubs. For some years he was a member of the industries committee of the Indianapolis chamber of commerce.

Whitfield P. Pressinger, New York, vice president, Chicago Pneumatic Tool Co., Chicago, who has been actively engaged in the pneumatic tool and allied machinery industry for many years, died recently. Mr. Pressinger was general manager of the Clayton Air Compressor Co. and was widely known through his activities in the various engineering societies.

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

The plant of the Dallas City Foundry Co., Dallas City, Ill., recently was damaged by fire.

The Woods-Evarts Stove Co., Springfield, Mo., contemplates the erection of an addition to its plant.

The Buckley Foundry Co., Springfield, Mass., plans the erection of a foundry, 85 x 100 feet.

The Eastern Foundry & Machine Co., Philadelphia, plans the erection of a plant, 60 x 120 feet.

The Turner Mfg. Co., Ft. Washington, Wis., contemplates the erection of a foundry.

The Driver-Harris Co., Harrison, N. J., will erect a number of additions including a foundry building.

Plans are being prepared for the erection of a foundry for the Ohio Brass Co., Mansfield, O.

Fire recently damaged the plant of the Foundry Mfg. Co., St. Albans, Vt.

Plans have been drawn for the erection of a pattern shop, two stories, 48 x 76 feet, for the Ideal Pattern Works, Lockland, O.

The capital stock of the Western Foundry & Mfg. Co., Springfield, O., recently was increased from $1000 to $30,000.

The Atlantic Foundry Co., Akron, O., has increased its capital stock from $500,000 to $1,000,000.

The Parker Pattern Works Co., Springfield, O., recently was incorporated with a capital of $25,000, by W. T. Parker, E. D. Parker and others.

The capital stock of the Lansing Foundry Co., Lansing, Mich., recently was increased from $150,000 to $350,000.

The Perfection Mfg. Co., Minneapolis, of which J. Morek is vice president, contemplates the erection of a foundry, 30 x 90 feet.

The N. K. Foundry Co., Brooklyn, O., recently was chartered with a capital of $1000, by A. R. Marsh, H. L. Burkdull, F. S. Witcomb and others.

The Duval Foundries, Jacksonville, Fla., recently was incorporated with a capital stock of $10,000, by A. T. Hill, C. J. Eppert and S. W. Hornibrook.

The Springfield Malleable Iron Co., Springfield, O., plans the erection of two factory buildings, both to be two stories, 30 x 50 feet.

The Fritzell Foundry Co., New Haven, Conn., recently was incorporated with a capital of $100,000, by O. Y. Fritzell, G. Fritzell and A. G. Anderson.

The United States Electric Co., New London, Conn., has let a contract for the erection of a foundry, 75 x 100 feet.

Plans have been completed by the Oswego Foundry Co., Oswego, N. Y., for the erection of an addition to its plant, two stories, 50 x 100 feet.

Contracts have been awarded by the Modern Welding & Machine Co., Pascagoula, Ala., for the erection of a machine shop and foundry.

The Dominion Steel Products, Ltd., Brantford, Ont., has started work on the erection of a new pattern shop.

The Art Foundry & Alloy Co., Cleveland, recently was incorporated with a capital stock of $10,000, by J. J. Schwab, S. Horwitz and others.

The Olney Foundry Co., Philadelphia, recently was incorporated with a capital of $600,000, by H. H. Cooke, S. B. Peck and Charles Piez.

The Atlas Foundry Co., Irvington, N. J., will erect an addition to its plant, 50 x 75 feet, to house its shipping and receiving departments.

The foundry and machine shops of J. S. L. Wharton, Philadelphia, have been sold to the H. S. & B. W. Cochran Corp.

The capital stock of the D. J. Ryan Foundry Co., Ecorse, Mich., recently was increased from $500,000 to $2,000,000.

The Morgan-Maass Products Co., Brooklyn, N. Y., welder, toolmaker and brass founder, recently was incorporated with a capital stock of $10,000, by S. G. Morgan, J. Wanser and H. C. Maass, 818 Fifty-ninth street, Brooklyn.

The Chatfield Machine & Foundry Co., Escanaba, Mich., has had plans prepared for doubling its plant, including the erection of a new foundry building.

The Weir Stove Co., Taunton, Mass., has awarded a contract for the erection of a foundry, 35 x 115 feet, a sand shed, one story, 48 x 60 feet, and a factory addition, three stories, 70 x 100 feet.

Capitalized at $5000, the Pittsburgh Gray Iron Foundry Co., Pittsburgh, recently was incorporated by George M. Hesack Jr., F. B. Wickersham and H. L. Allshouse.

The Bethlehem Foundry & Machine Corp., New York, recently was incorporated with a capital of $5000, by W. A. Wilbur, A. H. and R. H. Stevens, 149 Broadway, New York.

Architect H. Holder, 242 Franklin avenue, Brooklyn, N. Y., is preparing plans for the erection of a foundry, 100 x 250 feet. The name of the owner has been withheld.

The Westport Brass Foundry, Inc., Westport, Conn., recently was incorporated with a capital of $25,000, by W. A. Selde, C. D. Craig, Bridgeport, Conn., and H. R. Sherwood.

The Superior Pattern Co., Cincinnati, recently was incorporated with a capital of $10,000, by H. H. Schmees, R. Frankl, A. Frankl, W. Mentrup and others.

The Standard Brass Foundry, Portland, Oreg., recently was incorporated by Frank McCrillis, E. E. Small and others, and plans are being prepared for establishing a plant.

The Oldsmar Tractor Co., Oldsmar, Fla., is planning the erection of a plant, to include a foundry. The company recently increased its capital from $100,000 to $500,000.

The Beloit Iron Works, Beloit, Wis., has let the contract for the erection of an addition to its foundry, 117 x 160 feet, with 60-foot craneways for a 10-ton and a 15-ton crane.

The F. C. Blair & Son Co., Waukesha, Wis., gray iron founder, has purchased a plant site on which it is reported planning the erection of a new plant, work on which is to begin next fall.

The Michigan Foundry & Machine Co., Detroit, recently was incorporated with a capital of $40,000, by James R. Walsh, 476 Seyburn avenue, Detroit, and others.

Capitalized at $500,000, the Gartland-Haswell-Rentschler Foundry Co., Dayton, O., recently was incorporated by R. K. Landis, A. K. Meck and others.

The Charlotte Pipe & Foundry Co., Charlotte, N. C., plans the construction of a plant building, 100 x 100 feet. W. F. Dowd is president of the company.

Capitalized at $10,000, the Advance Bronze Aluminum Foundry Co., Cleveland, recently was incorporated by W. K. Gardner, L. M. Kelly, H. H. Gorman, M. L. Esch and I. Esch.

The Malleable Products Corp., Jamestown, N. Y., recently was incorporated with a capital of $500,000, to manufacture malleable iron, etc., by O. A. Lenna and others.

The Hugh Park Foundry Co., Ltd., Oshawa, Ont., recently was incorporated with a capital of $200,000, by Frank A. Park, James Parket, 157 Bay street, Toronto, Ont., and others.

The plant at 60 Elm street, Newark, N. J., formerly occupied by the Acme Brass Foundry Co., has been sold to Lewis Weitz, Paterson, N. J., representing a brass foundry concern. The building is 50 x 110 feet.

H. H. Sack and M. I. Rappaport, 365 Myrtle avenue, Brooklyn, N. Y., recently were named as the incorporators of the Clifford Brass & Copper Co., New York, which was chartered with a capital stock of $50,000.

The Molders' Foundry Co., Inc., Chelmsford, Mass., has been incorporated to operate a foundry and machine shop with a capital of $50,000, by Charles C. Knight, John H. Davis, E. Berg, Edward Carolin, Peter J. Hanson and others.

The Benton Harbor Malleable Foundry Co., Benton Harbor, Mich., has purchased the plant of the Crary Machine Works, and the latter company has bought a site on which it will build a new plant, 72 x 200 feet.

The Sam W. Emerson Co., 1900 Euclid avenue, Cleveland, has been awarded the contract by the Superior Foundry Co., East Seventy-first street and Aetna road, Cleveland, to construct a new foundry building.

A recent increase in the capital stock of the West Steel Casting Co., Cleveland, was made to care for the surplus in the present valuation of the company. It has a 100-foot plant extension under construction.

The American Metal Products Co., 671 Kinnickinnic avenue, Milwaukee, has purchased a site in West Allis, and expects to start work soon on the erection of a new foundry, 80 x 220 feet, and a new machine shop, 75 x 150 feet. The company recently increased its capital from $100,000 to $300,000. George F. Staal is president.

For the purpose of making a proportionate distribution of stock to cover plant additions and improvements of the past 20 years, which were paid for out of the company's earnings, the Trenton Malleable Iron Co., Trenton, N. J., recently increased its capital from $150,000 to $500,000. No additions or improvements are contemplated at this time.

Controlling interest in the Malleable Iron Works, New Britain, Conn., manufacturer of castings, has been purchased by Auburn, N. Y., interests. M. C. Swift, who was president has retired, and Herbert Swift, who was secretary, will remain with the new owners. A reorganization has been effected with the following officers: President, George W. Bowen; secretary, Walter H. Beck; and treasurer, George W. Benham.

The Cuyahoga Foundry Co., Cleveland, which was recently organized with a capital of $200,000, to manufacture gray iron and semisteel castings, is planning to engage in active business shortly. The company has a plant, 109 x 180 feet, equipped with 10-ton and 3-ton traveling cranes. Officers of the company are: President, John Vild; vice president, Anton Anyz; treasurer, Charles Wachalee, and secretary, Frank J. Opatrny.

Contracts will be placed in about 60 days for the erection of a new foundry, 60 x 160 feet, for the Judy Mfg. Co., Centerville, Iowa. This will be equipped with modern appliances and the company now is in the market for cupolas, sand cutting machines, molding machines, sandblast equipment, electric traveling crane, and flasks. Gray iron castings weighing from one pound to one ton will be produced in the new plant. The building will be of steel sash, glass construction. C. A. Farrington is president; A. W. Judy, vice president; A. M. Peatman, secretary, and George M. Barnett, treasurer. The company manufactures roller bearing mine car wheels, universal joints, concrete mixers and pavers and 4-wheel drive trucks.

The Delaware Aluminum Co., Muncie, Ind., is erecting a foundry and machine shop.

The Holaday-Telford Co., Waterbury, Conn., manufacturer of patterns, etc., has increased its capital from $10,000 to $60,000, and now has one of the largest plants of its kind in the New England district. It recently installed some new equipment.